ICIS 2024 Abstract Book

Contents

Back to top

Symposia Abstracts

S.01 Early Life Stress and the Infant Gut Microbiome

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Summary

This symposium will examine biological embedding of early life stress in the infant gut microbiome. Drawing upon two European and two North American cohorts, we examine associations between exposure to prenatal and early life stress in relation to the composition and function of the infant gut microbiome. Presentations consider factors such as different kinds of stressor, the timing of stress exposure during gestation and early life, the effects of extreme prematurity, the effects of exogenous corticosteroids, and the effects of a skin-to-skin intervention. Across the four studies, the findings suggest that different early life exposures (both positive and negative) have different implications for the early life gut microbiome. Our intention is to engage with a broad audience, including clinicians and researchers who might be new to the role of the microbiome in infant development.

Details

Abstract 1

Title: Associations between maternal emotions in pregnancy and infant microbiome at six weeks postpartum

Introduction. Prenatal exposure to maternal negative emotions and stress has been associated with less optimal neurodevelopmental outcomes and a higher risk of psychiatric problems in children, but the mechanisms underlying such effects are not yet understood. One possible mechanism is alteration of infant microbiome. Several studies found that prenatal stress may affect relative abundances of specific bacterial taxa in infants' gut microbiota (Zijlmans et al., 2015; Aatsinki et al., 2020; Weiss & Hamidi, 2023), but research in this avenue is still emerging.

Hypotheses. We tested the hypothesis that maternal emotions during pregnancy (including depressive symptoms, anxiety, perceived stress, and positive and negative affect) would predict diversity and composition of the gut microbiota in infants.

Study population. The sample consisted of 96 low-risk mother-infant pairs. Women aged 24 to 44 (55.6% of them were primiparous) were recruited in early pregnancy during their prenatal medical checks at two gynecological clinics in Czech Republic, Prague.

Methods. Maternal emotions were measured six times throughout pregnancy (twice in each trimester) using the Edinburg Postnatal Depression Scale, State-Trait Anxiety Inventory, Perceived Stress Scale, and Positive and Negative Affect Scale. The scores were averaged for each scale across pregnancy. In the next step, trimester-specific effects were tested. Infant stool samples for microbiota analysis were collected at six weeks postpartum. Microbiota was analyzed using amplicon sequencing of the V3-V4

hypervariable region of the 16S rRNA gene. The sequencing data were then processed into a matrix representing the relative abundance of each bacterial amplicon sequence variants (ASVs) in each sample. The effect of maternal emotions on microbial alpha diversity (measured by Shannon index and ASV richness) was tested by ANCOVA. The effect of maternal emotions on microbiota composition (assessed by presence/absence-based Jaccard dissimilarities and relative abundance-based Bray-Curtis dissimilarities in microbiota) was assessed using a distance-based redundancy analysis. Finally, we calculated the distances between each newborn microbiota sample and the population centriod and used them as response variables in the ANCOVA, testing the effect of maternal emotions on inter-individual variation in microbiota composition.

Results. We found no significant effects of maternal emotions in pregnancy on infant microbiota alpha diversity, composition, or inter-individual variation after adjusting for delivery mode. The results remained unchanged when analyzing data on emotions separately for individual trimesters. Delivery mode did not affect infant microbial alpha diversity, however, it was a significant predictor of infant gut microbiota composition, such that microbiota composition differed in infants born via spontaneous vaginal delivery (SVD) and emergency cesarean delivery (ECD), but not between those delivered through SVD and planned cesarean delivery (PCD). In addition, inter-individual variation in gut microbiota was higher in infants born via SVD compared with ECD or PCD, but there was no difference in gut microbiota inter-individual variation between infants born by ECD and PCD.

Abstract 2

Title. The Impact of Prenatal Stress on the Composition and Function of the Infant Gut Microbiome

Introduction. Substantial stress exposure during pregnancy results in changes to child physiology (e.g., gut microbiome), which may contribute to the biological embedding of prenatal stress in children's development. Emerging evidence suggests that prenatal stress impacts the composition of the infant gut microbiome but it is unclear how different types of stress (i.e., objective, subjective) affect the infant gut microbiome. Furthermore, most previous studies have only investigated how the composition of the gut microbiome is affected, without assessing the metabolites associated with the gut microbiome. This is important because many gut bacteria impact human physiology through the metabolites they secrete. The aim of this study is to investigate how different types of prenatal stress impact the infant gut microbiome and stool metabolome.

Methods. Pregnant participants were recruited during the first year of the COVID-19 pandemic. Prenatal measures of Pandemic Objective Hardship (POHI) and subjective mental health outcomes, such as anxiety symptoms (PROMIS) and depression symptoms (EPDS), were quantified. Stool samples were collected from infants at 3 months of age and analyzed for gut microbiome composition using metagenomic shotgun sequencing, and microbiome function using mass spectrometry (n=878). Spearman correlations were used to investigate the impact of prenatal stress on the infant gut microbiome and individual metabolites. MetaboAnalyst was used to investigate the impact of prenatal stress on stool metabolic pathways.

Results. POHI correlated positively with the diversity of the infant gut microbiome and 15 bacterial taxa (**Figure 1**), whereas no impact of subjective distress on the gut microbiome was detected. POHI also correlated with 51 of the 154 detected stool metabolites, which were implicated in metabolic pathways related to lipid, carbohydrate and bile acid metabolism (**Table 1**). Prenatal subjective distress was

associated with 14 stool metabolites. These effects were independent of covariates associated with the composition of the infant gut microbiome (i.e., breast vs formula feeding, mode of delivery, antibiotic exposure).

Conclusion. Prenatal objective stress has a greater impact on the infant gut microbiome and metabolome compared to subjective stress. These data provide novel insights into the potential to ameliorate the biological embedding of prenatal stress via the gut microbiome.

Abstract 3

Title. Daily Skin-to-Skin Contact Alters Microbiota Development in Healthy Full-Term Infants

Introduction. The gut microbiota plays a crucial role in human development and function. During the early stages of life, it coevolves with other important systems, such as the immune- and the central nervous system. The gut microbiota can influence the brain and the immune system via the gut-brain axis and vice versa, thereby having a long-term impact on the health of the individual. Various environmental factors influence the development of the gut microbiota, particularly during this sensitive period early in life. These factors include delivery mode, feeding mode, maternal microbiota, stress, and antibiotics. Skin to skin (SSC) contact between the mother and her infant can be considered a de-stressing intervention and previous research indicated that it prolongs the duration of breastfeeding, besides having benefits for maternal physical and mental wellbeing. In a randomized controlled trial on the effects of mother-infant SSC in healthy full-term infants, the gut microbiota was obtained as a secondary outcome measure. We hypothesized that alpha/beta diversity, microbiota maturation, and bacterial and gut-brain-axis-related functional abundances in microbiota would differ between the treatment and control group and that SSC infants would show decreased microbiota volatility.

Methods. A total of 116 healthy pregnant women were randomly assigned to either the skin-to-skin (SSC) or care-as-usual (CAU) groups. The SSC group participants engaged in one hour of daily SSC from birth to five weeks of age. Stool samples were collected at two, five, and 52 weeks and the V4 region of the 16S rRNA gene was sequenced.

Results. Results showed that the microbiota composition, bacterial abundance, and predicted functional pathways differed significantly between the groups. The SSC group exhibited lower microbiota volatility (**Figure 2**) during early infancy, and microbiota maturation was slower in the SSC group during the first year (**Figure 3**). Our findings suggest that breastfeeding duration may have only partially mediated this relation.

Conclusions. This study provides evidence that SSC in the first five weeks after birth may influence microbiota development in healthy full-term infants. To validate and generalize these results, replication is necessary. Future studies should extend microbiota sampling beyond the first year, include direct stress measurements to investigate stress as a potential mechanism, and research SSC's impact on long-term microbiota maturation trajectories.

Abstract 4

Title. Development of the Preterm Infant Gut Microbiome is Associated with Exposure to Stress-Inducing Procedures and Antenatal Corticosteroids.

Introduction. The human gut hosts a diverse multi-kingdom population of microbes, collectively termed the microbiome. The gut microbiome communicates bi-directionally with the brain via several mechanisms, forming the gut-brain axis, which is increasingly recognized as having broad contributions to human development. In animal models, the microbiome has been causally linked to dysregulation of the hypothalamic-pituitary-adrenal (HPA)-axis in early life; however, clinical research remains lacking. The HPA-axis is the principal regulator of stress responses through transient release of adrenal glucocorticoids (e.g., cortisol) to influence numerous physiological processes, such as inflammation. The relationship between the gut microbiome and stress response programming is of particular interest in infants born prematurely, as they exhibit distinct microbiome profiles due to higher rates of Caesarean section delivery, antibiotic use, and exposure to pathogenic microbes relative to term infants. Simultaneously, preterm infants endure frequent stress-inducing procedures during their prolonged hospital stays and often suffer from adrenal insufficiency, exhibiting inadequate cortisol secretion in response to stress or illness. With age, their stress responses can become increasingly maladaptive, heightening the risk of neurological, immune, and metabolic disorders. Together, this suggests altered gut-brain communication could play a unique and important developmental role in this population.

Hypothesis. We hypothesize that gut microbiome maturation patterns are bi-directionally associated with experiences of early-life stress and HPA-axis dysregulation in preterm infants.

Study Population. Data are from a prospective observational cohort examining microbiome development in infants born preterm (<32 weeks gestational age (GA)). The study includes weekly stool and urine sample collection in the first 8 weeks of life. Clinical factors (e.g., nutrition, medications, stress-inducing procedures) are recorded from hospital charts. This work presents findings from the first 41 infants recruited.

Methods. Composition of the bacterial and fungal gut microbiome derived from stool samples was evaluated by Shallow shotgun and ITS2 sequencing, respectively. Urine cortisol was measured by ELISA. Ecological (diversity metrics, relative abundance) and multivariate (mixed modelling) analyses were performed using RStudio.

Results. The preterm microbiome exhibits distinct maturational patterns depending on gestational age at birth, with infants born extremely preterm exhibiting lower bacterial alpha diversity, higher bacterial and fungal beta diversity, and higher relative abundances of pathogenic microbes (e.g., *Klebsiella*, *Escherichia*, and *Candida*) relative to very preterm infants. Generalized linear mixed modeling (**Figure 4**) revealed bacterial alpha and beta diversity were positively associated with antenatal corticosteroids and probiotics use, and inversely associated with stress-inducing (or skin-breaking) procedures. Fungal alpha diversity was also positively associated with antenatal corticosteroids and inversely associated with stress-inducing procedures and intrapartum antibiotics. Meanwhile, fungal beta diversity was positively associated with stress-inducing procedures. No direct relationships were observed between bacterial or fungal diversity metrics and urine cortisol.

Discussion. Our findings suggest a dynamic relationship exists between gut microbiome maturation and stress-related factors in preterm infants, with the degree of stress experienced in the first 8 weeks of life being linked to microbiome composition. Simultaneously, this work highlights the underexplored relationship between antenatal corticosteroids and the infant microbiome in early life.

S.02 Infancy in context: Emerging approaches and technologies

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Details

Abstract 1

Title: Three Questions about Infant Behaviors in Their Natural Environments Asked … and Answered

This talk asks and answers three questions concerning infants' behaviors in the natural environment of the home. Five-month infants were videorecorded for 1 hour, and 13 specific behaviors were operationalized, micro-coded, and analyzed; they included physical development of balance and movement; social interaction of looking at mother, smiling, and alert expression; looking, touching, and mouthing object exploration; nondistress vocalization; and distress expressed via face and voice. Behaviors were also organized into five overarching domains of physical development, social interaction, exploration, nondistress vocalization, and distress communication. The three questions concern: (1) the mean aggregate distributions of infant behaviors; (2) whether and how infant behaviors are similar or different; and (3) whether and how infant behaviors are organized. These questions were addressed in two samples: (1) in 796 infants from 11 countries around the world, including Argentina, Belgium, Brazil, Cameroon, France, Israel, Italy, Japan, Kenya, South Korea, United States and (2) in each of two contrasting cultural groups in each five of those countries, including urban and rural Argentines, monolingual and bilingual Belgians, urban and kibbutz Israelis, industrial and agrarian Italians, and metropolitan and Appalachian U.S. Americans. All infants were first born, healthy and term, and equal numbers of boys and girls were studied in each sample. Results were parallel in the two samples. In answer to the first question, the mean highest levels of infants' balance and movement matched their chronological age. Infants looked at their mothers the most and smiled the next most. Infants looked at objects more than they touched objects and touched objects more than they mouthed objects. Exploration exceeded social interaction. Infants vocalized nondistress a lot and much more than they vocalized distress or expressed distress in their facial affect. In answer to the second question, culture main effects emerged for the behavioral domains of physical development, social interaction, exploration, and nondistress vocalization. Patterns of cultural differences varied with behavioral domain, and no one culture exceeded or fell behind all other cultures across behavioral domains. By contrast, rates of infant distress did not differ across cultures. These results support both cultural specificities and similarities. Theories contrast with respect to coherence of behaviors in infancy. "Stage theory" predicts coherence, as stages are defined by covariation and organization in behavior. By contrast, a general biological principle of development asserts the "independence of systems;" different systems come "on line" at different times and differ in their trajectories of growth. The early ontogenies of brain regions and sensory systems are "staggered," and "decalages" (unevennesses in development) occur when infants demonstrate analogous capabilities in one domain but not in another. In answer to the third question, concerning coherences, among 10 possible correlations across five infant behavior domains, four were positive and significant (Mr = .14) supporting stage theory, but statistical significance was powered by the large sample size (N = 796), three more correlations were negative, and as a whole

infant behavioral domains shared less than 1% of their variance, supporting the modular, multidimensional, independence-of-systems perspective on infant behaviors.

Abstract 2

Title: Describing the Emotional Environment of the Infant

Emotion understanding—or the set of abilities related to determining the emotions of others—is crucial for the development of healthy social interactions. Emotion understanding allows us to respond appropriately to others' needs, make predictions about social interactions, and even regulate our own emotional responses effectively. Indeed, children who have better emotion understanding are rated as more socially skilled by teachers, more likable by peers, and are better able to navigate aggressive interactions. Likewise, children who have poor emotion understanding tend to be more aggressive, demonstrate poorer academic achievement, and have more behavioral problems.

Entire research programs have been devoted to studying the mechanisms required for emotion understanding in infants. However, the development of emotional understanding cannot be fully understood without an account of the *data* that are inputted into those mechanisms. In fact, we know very little about the emotional input infants receive in the real world. Here, we will use an existing naturalistic dataset to characterize the input for the early development of emotion understanding in infancy.

Data were coded from the SEEDLings—the Study of Environmental Effects on Developing Linguistic Skills—corpus. SEEDLings is an existing comprehensive, freely available, and longitudinal corpus of one-hour video recordings of 44 infants in their homes once a month from 6 to 17 months of age (Bergelson, 2016). In the videos, infants were wearing a head-mounted camera so that their field of view was visible. To date, the corpus has only been used to examine questions about language development. Here, we used the dataset to describe infants' exposure to emotion information. First, we documented how often infants see faces, and then coded those faces for emotional expressions. We then transcribed the videos to identify the emotion language most often used by caregivers.

In the talk, we will present base rate data for the amount of time infants look at faces and for the instances where they see emotional expressions and hear emotion language during their daily interactions across time points. Preliminary analyses demonstrate that even at the earliest time point (6mos) faces were partially visible (some portion of the mouth, nose, or eyes) for an average of 29.1% of the hour-long session, with fully visible faces available for only an average of 3.4% of the time. Further, data from both the facial and verbal coding suggest that infants are rarely exposed to stereotypical emotion categories like fear and anger, and emotion information across participants was instead highly variable, consisting more commonly of general positive and negative affect than specific discrete emotion categories. Finally, emotion information is often provided by multiple modalities at the same time. Indeed, infants who heard more positive emotion language also saw more positive facial expressions (happy, interest) at 6-8 months (r=.43, p=.004). Altogether, this work provides a new foundation for the development of infants' emotional understanding, setting the stage for researchers to use natural emotional input as a foundation for what and how they learn about emotions.

Abstract 3

Title: Co-Constructing Everyday Learning Opportunities by Infants and Caregivers Across the Second Year of Life

Everyday activities at home foster strengths for language, socioemotional, and STEM-related domains. Beginning in infancy, babies and caregivers work together to negotiate involvement in various tasks (e.g., Zhang et al., 2021). Investigations of the activities that infants participate in illuminate the diversity of learning contexts and how infants and caregivers co-construct these contexts. The present study, based on a subset of data from the PLAY project, examined developmental changes to naturally occurring activities that infants engage in. The study is the first step towards the research agenda to clarifying the "everyday lived experiences" (Rogoff et al., 2018) necessary for ecologically-valid and diversity-minded research.

The sample includes 28 mother-infant dyads so far (n = 9 at 12 and 18 months, n = 10 at 24 months; 60% female); data collection is still ongoing. Nineteen mothers identified their infants as White, 7 as Hispanic or Latine, and 4 as multiracial or other races. They were video-recorded for an hour as dyads went about their day; mothers filled out the ECBQ-Very Short Form on infant temperament. Nine activities were observed and coded for frequency and duration. Across age, infants spent substantial time playing with objects including household items and toys designed for children (M = 26 min).

The results so far revealed distinct patterns across age groups and temperament characteristics. Infants at 12 months had more meal time than older infants (M = 20 min vs. M = 6 min for 18 and 24 months). Age differences also merged in the variety of activities: Whereas 12-month-olds engaged mostly in object play and meals, 18- to 24-month-olds engaged in a greater range of activities. In particular, household chores (e.g., laundry, cleaning) and book reading increased with age (chores: M = .05 min at 12 months vs. M = 6 min at 18 and 24 months; book reading: M = 0.3 min at 12 months vs. 7 min at 18 and 24 months). Moreover, older infants took more leads in initiating and completing activities.

On temperament, infants higher in effortful control tended to spend more time in household endeavors regardless of their age. It suggests that infants perceived by mothers as having such characteristics were more likely to be invited to doing household chores. Although household chores are not designed specifically for infants, they provide infants with culturally meaningful contexts to learn and collaborate. No gender difference was observed, U = 83, p = 0.58, η_2 = 0.01.

In summary, the results so far provide important insights into early learning. In the second year of life, infants take part in activities in manners that are sensitive to their age and temperament characteristics, allowing them to co-construct everyday learning opportunities with caregivers.

Abstract 4

Title: Language Interactions in the Home Environment are Rich with Contextual Regularities

Before researchers looked closely at the language experiences of infants in natural settings, and before they had the tools necessary to capture and annotate behavior and speech in context, they made assumptions. Language environments were assumed to be impoverished (at one extreme) or complex and messy (at the other). But that's not the case. A growing body of research—grounded in infants' everyday language interactions in the home environment—indicates that speech to infants is rich with

regularities. In this talk, I present findings on the contextual regularities that characterize infants' everyday language experiences.

Across four studies, we videorecorded infants and their mothers for 1- to 4-hours per dyad in the home as they went about their everyday activities (*N*s range from 30 to 150+ dyads, English- and Spanish-speaking families). Videos were transcribed, and utterances were time-locked to videos and annotated for several features of context. Annotations included: (1) the activity context of the interaction (e.g., mealtime, bath time, toy play); (2) the location context of the interaction (e.g., kitchen, bathroom, bedroom); and (3) the referents of infant-directed speech (e.g., the objects that were the target of talk).

Study 1 shows that everyday activities frame language interactions such that infants are likely to hear specific words from specific semantic categories during specific routines, with exposure to other semantic categories being suppressed in that routine. Study 2 shows that everyday routines are tied to the places & spaces of life: Infants are exposed to specific words in specific rooms and locations (e.g., highchair in a kitchen). Study 3 shows that the materials (e.g., household objects, toys) of interactions shape language input. For example, caregiver talk about "abstract" concepts—namely words that refer to spatial relations (e.g., up, down, next-to), number, and magnitude and quantifiers (e.g., bigger, small, more)—occurs in the presence of salient objects and actions that specify word meaning (e.g., hearing "up on top" as the infant climbs up the couch). At the same specific words are repeated in varied contexts that challenge infants to extract a word's invariant meaning based on distinct perceptual experiences (e.g., hearing "up on top" as well when a cup is placed on a table top). Finally, Study 4 translates insights from home observations to structured tasks by zeroing in on the material context of language interactions. We show that by manipulating the materials of infant-caregiver play, we alter the speech that caregivers direct to their infants and likewise the words that infants produce.

Taken together, findings underscore the embodied and embedded nature of infants' language experiences. In everyday life, infants are challenged to extract word meaning from speech streams. Notably, environmental regularities scaffold the learning process. Specifically, the home environment offers converging redundancies and multiple inroads for infants to break into the speech stream and connect words to meaning. Infants reliably hear words that align with the activities and locations of everyday life in an environment filled with cultural artifacts that guide infants' behaviors, and in turn the topics of talk.

Abstract 5: Full-day wearable sensor measurements reveal age-related increases in infant positional variability

Developmental changes in infants' motor skills opens up new opportunities for exploration. Some aspects of motor skill change are well-characterized: Over the first year of life, infants spend increasingly less time supine on their backs and more time sitting and upright as they gain the ability to independently sit and walk. However, we lack information about whether and how the temporal structure of motor experiences changes. Gaining the ability to transition between different positions may allow infants to more frequently switch between positions rather than stay in a single, dominant position for long periods, which, in turn, may offer more varied exploratory opportunities. Alternatively, over the course of daily activities (e.g., playing vs. feeding vs. media viewing) caregivers may restrain infants or otherwise structure movement such that infants' burgeoning motor skills do not increase local variability in movement. Thus, the present study aimed to characterize age-related changes in the local variability of infants' everyday motor activity across day-long recordings.

Since it is not feasible to video record and manually code motor activity across an entire day, we employed a novel inertial sensing method in which infants wore a custom pair of leggings embedded with sensors at the hips and ankles (Figure 1A). A previously validated machine-learning algorithm classified whether infants were supine, prone, sitting, or upright based on inertial sensor data (Franchak et al., in press). Here, we report preliminary data from an ongoing longitudinal study in which infants' activity was recorded monthly from 4-7 months (18 infants) or from 11-14 months (29 infants), with data from 101 total sessions. Data collection started in the morning at the earliest time convenient to the family and lasted until the infant's bedtime; naps, diaper changes, and excursions out of the house were noted by the caregiver and excluded. The remaining time provided usable data, ranging from 5.3-11.9 hours per infant (M = 9.2 hours). We estimated the proportion of time infants spent in each of the four positions in sliding 10-minute windows across the day.

As in prior work, older infants spent less time supine and more time sitting and upright; prone did not significantly differ. However, the primary focus was whether a single position dominated each 10-minute window or whether body position varied. We calculated the proportion of 10-minute windows in which each infant stayed in the same position versus experienced more than one position. Positional variability significantly increased with age (Figure 1B): M = 76.6% of older infants' periods contained more than one position compared with only M = 57.0% for younger infants. For periods where the infant stayed in a single position for the entire 10 min, younger infants were most likely supine whereas older infants were most likely sitting.

Both findings suggest increased opportunities for exploration for older infants. Long bouts of sitting (compared with supine) are advantageous for visual-manual exploration, and more variable positioning from moment to moment may offer varied views and access to different places and objects.

Abstract 6: Toy intelligence: Automated monitoring of general movements and natural object play

Everyday motor actions are more than simple muscle responses to environmental stimulation. They involve complex sequences of goal-oriented, multi-body-segment movements to perform biologically adaptive behaviors that reflect critical and foundational components of human cognition.
We examined a novel methodological approach that includes high-frequency behavioral sampling and advanced quantitative analyses to automatically record infants' everyday experiences at home using wearable technology and "intelligent toys"—custom-built objects with embedded sensors to capture children's object play based on 3D-reconstruction techniques from geometric robotics.

In a few feasibility projects, infants (0 to 36 months) provided with "wearable technology jumpsuit" embedded with micro-sensors that capture infant motion, and "intelligent toys" (suitable for a range of developmental stages in the first year of life) that capture their object use during daily play in their home. Data from the jumpsuit and the toys were pulled automatically on a near-weekly basis to monitor parents' use of those materials. The jumpsuits record 5 minutes of infants' motion from 8 key joints of their limbs. The toys capture six degrees of freedom in toy poses for each use.

The power of using the intelligent toy was validated using video recordings of infants at their homes. We manually coded infants' general movements and toy manipulations and compared them to the data from the sensors in the suits and toys. Our algorithms identified how and when the toy was manipulated with 98% accuracy and were able to capture the general movements identified in the videos.

Specifically, we evaluated the times of play in each toy, the kinematic variability of play (movement amplitude, velocity, left-right asymmetry, and inter-limb coordination) and the play variability (the different ways different toys were used). For the suits, we captured infants' general movements—spontaneous, unstructured movements that occur naturally—as assessed in the Prechtl's Method of the Qualitative Assessment of General Movements which is a well-established diagnostic tool used in early infancy.

We will also discuss several challenges in testing infants with this state-of-the-art technologies which include limitations in understanding the situational contexts (e.g., the same movement pattern might indicate different things depending on whether the infant is tired, playful, or uncomfortable), using sensors which are typically affixed to specific objects (e.g., missing out on capturing a wide range of natural movements that occur when using bricks which cannot be intelligent), and addressing ethical and privacy concerns (e.g., when others use the toys).

Our findings demonstrate the feasibility of capturing the endless variety of perceptual-motor experiences of children from birth as they reach for and interact with a variety of objects (differing in orientation, shape, size, compliance, etc.) in the course of exploration and instrumental use. Our wearable technology jumpsuit and the intelligent toys promise to pave the way for new research of developmental disorders using the toys as a clinical instrument.

Abstract 7: Exploring patterns of physical proximity in everyday life of infants

At birth, the human brain is inherently poised to undergo profound shaping through experience. Caregiver interactions play a pivotal role in experience-dependent learning. However, understanding the impact of everyday caregiving experiences remains relatively unknown given that past research relied heavily on laboratory-based assessments, which by necessity cannot capture the complexity of a child's real-life experiences with multiple caregivers across varied contexts and schedules and across development.

In the present study, we implement a new wearable device (i.e., the TotTag) to assess patterns of physical proximity between infants and their parents (mothers and fathers). TotTags use three UWB antennas and a Bluetooth Low Energy (BLE) radio, plus a battery charging circuit, SD card for data logging, accelerometer, USB connectivity, and integrated sensor fusion to continuously and unobtrusively collect time-of-flight information regarding the proximity between devices. The TotTags capture second-by-second distance estimates within 1-2 inches accuracy with all other devices in a network. Applied in infant and young children's everyday lives, this technology may yield new insight into the interactions with caregivers that are fundamental to child development.

30 families from an ongoing longitudinal study have been enrolled to examine physical proximity among caregivers of children ages 1, 6, 12, and 18 months. TotTag data from the age 1 month assessment has been acquired and processed for 16 families (mean infant age = 5.50 weeks, SD = 1.18). At the time of the ICIS meeting, we anticipate these families will have also completed the age 6 months assessment.

At each study wave, all family members were asked to place TotTags in waist packs (adults) or in a tailor-made vest with pockets for both a TotTag and a LENA audio recording device (infants) at their morning wake-up and to remove the TotTags for charging directly following the infant's bedtime across 4 consecutive days (2 weekend and 2 weekdays).

We examined time in close contact (<3 ft) between the infant and each parent (if available), patterns across week vs. weekend days, and associations between time in close proximity and adult word counts from the LENA audio recordings.

Preliminary findings indicate that birthing parents (mothers) spend more time in close proximity to their infants (minutes within <3 ft distance) compared to other parents (fathers) on both during weekdays (d = 0.51) and on weekend days (d = 0.43). In terms of family-level differences, infants whose mothers spent more minutes in close contact with them were exposed to more adult words (r = .33). At this study wave, our data indicated that both caregivers tended to spend more time in close proximity on the weekday compared to the weekend (mothers d = 0.48; fathers d = 0.28), and this effect was more profound for mothers.

This study introduces a new approach to capturing how children's everyday contact with caregivers varies across families, context, and age; as well as allows for a child-centered approach to examining contact with multiple caregivers.

Abstract 8: Exploring automatic ways of measuring caregiving quality during early child-caregiver home interactions

Numerous lines of evidence suggest that the sensitivity, responsivity and predictability of caregiving behaviours are strongly predictive of child developmental outcomes (Glynn & Baram, 2019; Vernon-Feagans et al., 2016). But most of our methods for measuring caregiving quality in humans focuses on short, video-coded interactions.

This approach brings with it a number of well-recognised problems. Relying on short 'snapshots' of parent-child interaction quality limits the range of questions that we can ask – such as, for example, how parental sensitivity fluctuates over time, contingent on environmental factors. Video-coded observer interactions are also subjective and coding is labour-intensive. And parents are, naturally, on 'best behaviour' during a short interaction - when they are aware of being observed, and so do not necessarily interact with their child as they would do otherwise.

Devices such as the LENA allow for fully automatic, in-depth monitoring of how contingently a caregiver responds to their child's vocalisations in home settings. But, beyond there, there currently exist virtually no techniques that allow us automatically to monitor caregiving quality during early caregiving interactions. For example, no techniques exist for measuring caregiver vocal and facial affect, how child displays of vocal and facial affect are mirrored contingently by the caregiver, and for quantifying large scale predictability vs unpredictability in caregiving behaviours.

To address this, we have developed wearable devices consisting of integrated child- and caregiver-worn electrocardiogram, actigraph, GPS, caregiver-child proximity sensor, microphone, and camera (Fig 2D-G). We are using these devices to measure caregiving quality in a variety of different ways:

First, we are using machine learning classifiers to identify cries and neutral vocalisations in the infant microphone data, and analysing the caregiver physiology data to identify how they upregulate their physiological arousal in response (Fig 2A). Bootstrapping analyses indicate that caregivers upregulate their arousal more in response to an infant cry than to a neutral vocalisation (Fig 2H-J) (both ps<.001). They also suggest that the more caregivers upregulate their own arousal in response to an infant cry, the

Back to top

faster the infant soothes in the time window 3-5 minutes following the event (Fig 2K), validating this as a short-term measure of caregiver responsivity (all corrected ps<.001).

In ongoing work, we are also developing a number of other fully automated ways to measure caregiving quality remotely. First, we are analysing child- and caregiver-worn cameras using machine learning classifiers to identify facial expressions in the child and the caregiver (Fig 2B), and using them to examine features such as reciprocal smiling and affect mirroring. Second, we are analysing child- and caregiver-worn microphone data using classifiers to identify vocal affect and intensity (Fig 2C), and using this to examine affect mirroring in vocal behaviours. Third, we are using automatic text transcription to identify different categories of caregiver response to emotional displays in the child. At the presentation we will present summaries of progress on all these approaches.

S.03 What can we learn from infant caregiver dyadic play in infants with and without disabilities

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Summary

This symposium will start with a description of the enactive model of play and how it is implemented in practice. A relationship between a caregiver and an infant can be positively and negatively impacted by preterm birth and prolonged medical courses. Paper 2 with highlight changes in emotional availability in response to therapeutic intervention and consider the implications for practice. Measures of play are often captured during short interactions. Paper 3 will demonstrate the use of wearable sensors to measure all-day activity and position. The final paper compares the adherence to intervention principles embedded in play. Together these 4 papers will introduce the participant to a variety of measures used to quantify the impact of play on development. Theoretical models, manipulation of the timing of intervention, measurement using sensors and emotional availability will all shed light on how to maximize development in children with and without disabilities.

Details

Abstract 1 Title: Enactive Understanding of sensory-motor Play and how it applies to Pediatric Physical Therapy

Abstract 1 Text: Introduction: Sensory-motor play is fundamental in infants' development of new skills and how they learn to make sense of themselves and their surroundings. Based on this view, pediatric physical therapists (PPTs) are encouraged to integrate play into their therapeutic approach. The enactive theoretical framework can bring new insights into how we understand infants' sensory-motor play, and how professionals can use play as a therapeutic tool. In our initial explorations of this field, we established the concept of 'enactive therapeutic sensory-motor play' as an approach in which therapeutic goals and actions are successfully merged with children's play. This entails that the PPT must recognize an infant's attention and motivation, and simultaneously plan and pursue a therapeutic strategy as part of engaging, interactive sensory-motor play activities with the infant. The PPT's choices

and actions all need to be part of the play, not a disturbance to it. To further explore this knowledge field, we continue our development of this concept.
Research question: How can further developments of the concept of 'enactive therapeutic sensory-motor play' improve the understanding and theoretical foundation of pediatric physical therapy practice?
Study population: This study includes interviews of 15 PPTs and observation of 29 therapy sessions with children aged 0-3. The populations are situated in Norway and the USA.
Methods: This is a qualitative study with a collection of observation and interview data. Each PPT was observed in treatment sessions together with two children on their caseload. The treatment sessions were also video recorded. After the sessions, we conducted a semi-structured interview, including viewing selected clips from sessions for a detailed discussion about the ongoing therapeutic play. The data is analyzed with an interpretative content analysis approach using NVivo software for sorting of data. The analysis approach is abductive with connections to enactive theoretical perspectives.
Results: Enactive therapeutic sensory-motor play is further developed with new insights from observations about how bodily interactions and therapeutic handlings that are mutually incorporated can enrich the infant's movement learning. The therapeutic bodily interplay and the PPTs' subtle guiding of movement can provide novelty and facilitate the infant's sense of agency in the self-initiated exploration and refinement of movement possibilities. In a dynamic bodily dialogue, the infants can make use of new and additional support surfaces to self-initiate better posture and movement solutions and reach play goals. The interview material provides new knowledge about the tensions between play and therapy. The PPTs explain that they find the integration between the two challenging. They feel that they often fail to connect with and uphold the infant's play engagement and simultaneously accomplish their therapeutic goals. Nonetheless, they acknowledge that there is no other way to do therapy with infants than to have it embedded in play, and with experience, they learn to deal with the unpredictable and creative way of thinking that is needed to problem solve and find new ways of merging their therapeutic intention with the infant's play.

Abstract 2 Title: Developmental Trajectories of Emotional Availability Differ in Parents and Children with and without Motor Delays

Abstract 2 Text: Introduction. In line with developmental cascades – motor development is often described as a control parameter for cognitive and language development (Bornstein et al., 2010; Iverson, 2010). In addition to using motor skills to act and learn – children use motor skills to guide their play interactions with their parents. In turn – parents use children's advancing motor skills as a way to guide the complexity of play. Due to the grounding of children's early learning and social interactions in gross motor experiences, dyads with children with motor delay may be at risk for alterations in Emotional Availability (EA). EA reflects the dyad's ability to share a healthy emotional relationship and has important implications for children's adaptive development (Biringen et al., 2014). The purpose of this analysis was to quantify the impact of motor delay on the EA during play in young children with and without motor delay.
Hypothesis. Consistent with evidence on dyads with children with Autism Spectrum Disorder, we hypothesize that motor delay will impact child EA more so than adult EA and that the impact of motor delay on EA will be moderated by the severity of motor delay (Bentenuto et al., 2020).
Study Population. Data were drawn from 99 young children with and without motor delay (Mild motor delay, N=34, baseline age=9.26 months; Significant motor delay, N=30, baseline age=11.85 months; Typical motor development, N=35, baseline age=5.71 months).
Methods. EA was quantified using the EA Scales 4th edition on 5-minute videotaped parent-child interactions at baseline, 3-, 6-, and 12-months post-baseline. EA trajectories were described and

Back to top

compared using multilevel growth modeling with unstructured variance and child-level random effects. All models controlled for baseline mean-centered age and parent-reported education level. Estimates of linear change for time since baseline indicate an estimated change in EA within or between groups for each month in the study. Cohens d and Hedges g effect sizes are based on the estimated 12-month change in EA.
Results. Trajectories of EA in children with mild motor delay differed from typical motor development in Child Involvement (b=24, p=.03, g=.63). Trajectories of EA in children with significant motor delay differed from typical motor development in Total EA (b=1.12p=.02, g=.66), Sensitivity (b=.21, p=.03, g=.70), Child EA (b=.63, p=.00, g=.94), Child Responsiveness (b=.21, p=04, g=.59), and Child Involvement (b=.42, p=.00, g=1.23). There were no differences in trajectories between children with mild or significant motor delay.
Conclusion. Consistent with our hypotheses and previous evidence, having a motor delay impacted dyadic EA and the severity of motor delay moderated the risk of EA. Overall, dyads of children with significant motor delay had difficulties in EA at the adult and child level whereas mild motor delay impacted EA at the child level only. Dyads with motor delay may benefit from early interventions that support EA during play-based therapeutic activities.

Abstract 3 title: Measuring postures of infants across full days: Examples from infants with typical and atypical development.

Abstract 3 text: Introduction. Different infant body postures (e.g., supine or sitting) present distinct opportunities for play, influencing what infants play with and how they interact. Postural control, motor skills, interactions with gravity, and the visual field all differ between postures. Here, we used a novel wearable sensor suit system to quantify postures during spontaneous behaviors and play in infants at risk (AR) for developmental disabilities across full days in the natural environment. Hypothesis. We hypothesize that infants AR will spend more time in less advanced body postures (supine, side, prone) and less time in more advanced body postures (sitting, crawling, standing, walking) compared to their age-matched peers with typical development (TD). Study population. Three infants broadly AR participated in pilot testing, 2 at 8 months of age and 1 at 14 months of age (adjusted for prematurity as appropriate). Comparison data for infants with TD were provided from an existing database of recordings (n = 482 recordings). Methods. We used a previously developed and validated MAIJU suit (Airaksinen et al, 2022) equipped with tri-axial movement sensors attached proximally to each limb. The suit was worn for a full day (~8-14 hours) while behaving and playing freely in a natural environment. A fully automated and validated, deep learning-based algorithm (Airaksinen et al., 2023) was used to track body postures for each second of the recording. Results. Figure 1 shows the mean and standard deviation for the proportion of the recording spent in each posture from a sample of infants with TD (n = 33 at 8 months of age and n = 32 at 14 months of age). Figure 1A shows example data from two infants AR at 8 months of age, while Figure 1B shows example data from one infant AR at 14 months of age. In regard to our hypotheses, the younger infants AR generally appeared to spend more time in the less advanced body postures of side and prone, and less time in more advanced body postures of crawling or standing compared to their age-matched peers with TD. The older infant AR generally appeared to spend more time in the less advanced body posture of prone, and less time in more advanced body postures of crawling or sitting (and did not demonstrate walking) compared to age-matched peers with TD. However, most individual data points from the infants' AR were within the standard deviation of the normative sample. Further, we have not considered here if infants' AR were being held or carried in certain positions, for example, this may explain the high proportion of side posture measured for one of the infant's AR. Preliminary data support that the wearable sensor suit system can be used to quantify postures during spontaneous behaviors and play in infants' AR across full days in the natural

Back to top

environment. This is only a preliminary visual interpretation of example data; a larger sample and further analysis are needed before any interpretations can be made.

Abstract 4 title: Training Parents of Preterm Infants to play, Does Timing Matter?

Abstract 4 text: Introduction: Infants with or at risk for developmental disabilities are encouraged to practice movement that is self-generated, and build on their ability to engage with caregivers and the environment. However, one consequence of preterm birth can be low or high muscle tone, strong extension or arching preferences, difficulty self-regulating, and autonomic instability when overwhelmed with input. Supporting Play Exploration and Early Developmental Intervention (SPEEDI) is a program designed to support parents' attempts to enhance their very preterm infant's global development. For SPEEDI to be effective it is crucial that parents learn to provide the intervention activities independently and with high fidelity to the intervention principles. The purpose of this analysis is to compare the adherence to the SPEEDI principles in dyads who provided intervention in the neonatal intensive care unit and continued practicing for the next 2-12 weeks at home (SPEEDI_early) against the adherence of dyads who were 12-16 weeks adjusted age when training started and continues for 15 weeks till 27 to 31week of adjusted age (SPEEDI_late)
Hypotheses: Dyads in the SPEEDI_Late group will have a lower rate of adherence to the intervention principles than the SPEEDI-early group.
Study Population: Infants were participants in either intervention arm of the clinical trial evaluating the efficacy and timing of the SPEEDI Intervention. Mean gestational age was 26 weeks, 93% were non-Hispanic, 55% White.
Methods: Intervention sessions were videotaped. The treating therapist completed a self-assessment and 20% of the visits were scored for reliability by a second rate. With high reliability between raters, the interventionist's own ratings were used to quantify adherence for each visit. A linear mixed model with fixed effects for visit or phase, Group (when called for) and group*visit (or group*phase when called for), and a random effect for the subject to account for within-subject variability.
Results: Neither group had a significant change in adherence over time nor was there a significant effect of the visit ($F_{8,120} = 1.29$, $p = 0.2565$). When comparing phase 1 (direct parent education during these sessions) with phase 2 (parent-delivered intervention independently) intervention, change in adherence differed by group. SPEEDI_early marginally increased adherence during phase 2, ($F_{1,134} = 3.30$, $p = 0.0714$), while SPEEDI_late decreased adherence in phase 2 ($F_{1,201} = 4.55$, $p = 0.0341$). There was a significant visit by group interaction ($F_{8,303} = 2.11$, $p = 0.0345$)
Discussion: Very preterm infants and their parents can learn to provide developmentally supportive play interventions. However, the timing of this intervention appears to be important. If conducted when the very preterm infant is medically stable but skill in the NICU adherence increases over time suggesting parents are getting better at performing the intervention. The increasing adherence for the SPEEDI_Early group, with a decline in the SPEEDI_Late suggests that training parents to provide the intervention following specific key ingredients may lead to more consistent delivery when the caregivers are establishing routines at home rather than starting several months after discharge.

S.04 Tiny Faces, Tiny Expressions - When and How to Use Infant Facial Electromyography

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Summary

Infant facial electromyography (fEMG) is an innovative method enabling objective assessments of overt and covert movements of facial muscles, such as those involved in smiles (zygomaticus major [ZM]) and frowns (corrugator supercilii [CS]). Talk 1 unveils the emergence of facial mimicry in 4- to 5-month-olds in response to audiovisual crying and laughing. Talk 2 reveals 11-month-olds' selective facial reactions to the 'emotional body' (i.e., happy and angry kinematics, caresses and scratches tactile interactions). Talk 3 shows 10-month-olds' positive emotions during infant-led interactions and positive attitudes toward actors following their gaze, as indicated by enhanced ZM activity. Our discussant ties the talks: Where does infant fEMG research currently stand and where should it be heading conceptually and methodologically? Together, we outline an array of research questions answerable with fEMG and portray the state of the art of this promising method in infancy research.

Details

Abstract 1, Facial Mimicry in Response to Dynamic Emotional Stimuli in Five-Month-Old Infants: Humans often spontaneously and unconsciously match their behaviors to others. In particular, spontaneous matching of facial expressions, often termed facial mimicry or spontaneous facial reactions, plays a crucial role for our smooth social interactions. Despite the accumulated evidence of facial mimicry in adults, little is known about their development. To clarify when and how facial mimicry develops, the present study examined the spontaneous facial reactions to emotional expressions in infants. We utilized facial electromyography (fEMG) measurement, which allows for the analysis of even subtle responses of facial muscles with high temporal resolution in a more objective manner. We speculated that infants' facial mimicry responses would develop in tandem with their emotion recognition ability, thus we focused on 4- to 5-month-olds, who are at the age known for the initial development of emotion recognition. Moreover, as it has been shown that infants first become able to discriminate emotions from audiovisual bimodal stimuli around this age, and that this ability later expands to unimodal auditor and visual stimuli, we examined the effect of modalities of emotional displays on the infants' facial reactions. We hypothesized that 4- to 5-month-old infants would demonstrate facial mimicry responses to audiovisual emotional displays, but may not to unimodal stimuli (Figure 1A, left). The final sample consisted of 15 full-term 4- to 5-month-old infants (nine males and six females, M_{age} = 154.6 days; SD_{age} = 10.0 days; ranging from 140 to 169 days). Infants viewed a series of video clips where adults dynamically expressed crying, laughing and neutral emotions with audiovisual (AV), visual (V) and auditory (A) modalities. Modalities refer to those related to emotion; all stimuli contained both visual and auditory information, but in the unimodal (V and A) emotion conditions, an emotional facial expression or vocalization was paired with a neutral vocalization or facial expression, respectively. While the infants viewed the clips, we recorded their fEMG activities over the left corrugator supercilii and zygomaticus major. The results showed increased activations of the corrugator supercilii in response to audiovisual crying, and of the zygomaticus major in response to audiovisual laughing, between 500 and 1000 ms after the stimulus onset ($Z = 3.2$, $p = 0.0004$; $Z = 3.0$, $p = 0.001$, respectively, Figure 1A, right). These results clearly demonstrate that facial mimicry is present as early as 5 months of age when multimodal emotional information is provided. Conversely, in the V and A conditions, no significant differences in fEMG activity across emotions were found in any time window for both muscles, suggesting that 4- to 5-month-old infants do not show facial reactions towards emotional faces and vocalization. Since adults are known to exhibit facial reactions to even unimodal emotional stimuli, our findings imply that 4- to 5 months-old infants have begun to construct a system eliciting the facial mimicry, but at this stage, the system has matured only to the extent that motor

Back to top

responses are triggered exclusively when multimodal emotional information is provided. The implications of these findings will be discussed in the context of subsequent research.

Abstract 2, Using Electromyography to Capture Infants' Facial Responses to the "Emotional Body": Something in the way people move and interact with others tells us about their affective states. We can infer others' emotions by observing how people walk or perform simple object-directed actions, such as drinking and knocking. We can even recognize others' emotions by observing how people interact, for example, through affective or non-affective tactile stimulations. However, very little is known about infants' ability to pick up on affective information from body movements. Facial electromyography (fEMG) is a promising tool to study not only infants' responses to emotional facial expressions but also to other emotion-related stimuli, such as bodily movements and interactions (Figure 1B, left). Here, I will present two studies that employed fEMG to explore 11-month-olds' sensitivity to the emotional information conveyed in action kinematics (Study 1) and tactile interactions (Study 2). In both studies, fEMG activity was measured over the zygomaticus major (ZM) and corrugator supercilii (CS) muscles, respectively involved in positive (i.e., smiling) and negative (i.e., frowning) facial expressions. In Study 1, fEMG activity was measured while infants observed videos of the same grasping action performed with happy or angry kinematics. Mean amplitude values expressed as z-scores were analyzed in a 2 (Emotion: happy, angry) × 2 (Muscle: ZM, CS) repeated-measures ANOVA that showed a significant Emotion × Muscle interaction, $F(1,16) = 17.34$, $p = 0.001$, $\eta p2 = 0.52$. Angry kinematics elicited stronger CS activity compared to ZM, $t(16) = 3.77$, $p = 0.004$. Differently, observing happy kinematics yielded an increase in ZM activity compared to CS, $t(16) = 4.17$, $p = 0.003$ (Figure 1B, right). Results show that 11-month-old infants respond with selective and matching facial reactions to the emotional content of both angry and happy action kinematics. In Study 2, fEMG activity was measured while 11-month-olds observed videos of positive (Caresses) and negative (Scratches) tactile interactions. A 2 (Touch: Caress, Scratch) × 2 (Muscle: ZM, CS) repeated-measures ANOVA revealed a significant Touch x Muscle interaction, $F(1,23) = 4.86$; $p = .038$, $\eta p2 = .17$. fEMG activity over ZM muscle was significantly greater during the observation of a caress compared to a scratch, $t(23) = 2.91$; $p = .008$ (Figure 1B, right). Thus, the observation of a caress evoked a positive emotional facial response in the infant. Differently, no selective activation of the CS in response to the observation of scratches was found. Overall, these findings show that emotional signals conveyed in action kinematics and tactile interactions evoke specific and emotionally congruent facial responses in the infant. fEMG represents a promising and versatile tool to capture infants' 'tiny' facial responses to a variety of emotional signals that surround their social world.

Abstract 3, The Development of the Affective Mechanisms Underlying Gaze Leading in Infancy: We know that infants are social from the outset (e.g., Morton & Johnson, 1991; Reid et al., 2017) and experience pleasure in social triadic interactions (Adamson & Bakeman, 1985). However, we do not know whether different types of triadic interactions elicit different affective responses. Our study focuses on the affective consequences of infants' active role in triadic interaction. Infants not only passively follow others' gaze but also recognize (Grossmann et al., 2013; Rayson et al., 2019) and anticipate (Phillips et al., 2023) their active leading of others' gaze. Gaze leading is rewarding for adults (Schilbach et al., 2010), but only little is known about the affective mechanisms underlying gaze leading in infancy (Venezia et al., 2004; Venezia Parlade et al., 2009). To deepen our understanding of infants' socio-emotional ontogeny, we tested N = 69 4-month-old (range = 4 months and 2 days to 5 months and 15 days, M = 147.17 days, SD = 9.62 days, 34 females) and N = 61 10-month-old (range = 10 months 0 days and 11 months 2 days, M = 318.21 days, SD = 8.71 days, 24 females) WEIRD infants in a preregistered (https://osf.io/k5ytr/?view_only=da6112da7e5d4f16b1a6cc3595f8babb), gaze-contingent, screen-based eye-tracking study in which infants could either lead an actor's gaze toward an object or failed to do so (gaze-leading task). Infants saw the actor who always followed and another

actor who never followed the infants' gaze individually in the beginning and end of the experiment (actor-preference task) (Figure 1C, left). We measured infants' affect in response to (not) leading others' gaze (gaze-leading task) and to actors who did (not) follow infants' gaze (actor-preference task) using facial electromyography on the muscle innervated while smiling (zygomaticus major [ZM]) and frowning (corrugator supercilii [CS]). Additionally, we video-coded infants' smiles and frowns. As expected, 4-month-olds did not show any condition differences in any task in any measure (all ps > .05). The older age group, as hypothesized, exhibited enhanced activity of the ZM after leading others' gaze, $t(40) = 2.04$, $p = .05$, $d = 0.63$, and after seeing the actor who has previously followed their gaze, $t(28) = 3.15$, $p = < .01$, $d = 0.68$ (Figure 1C, right). Surprisingly, we did not observe these differences in the video-coded smiles, even though video-coded smiles substantially correlated with the ZM activity ($r = .47$, $p < .001$). It might be that subtle smiles, difficult to observe with the naked eye, drove the effect. We did not find any differences between conditions in either task in the activity of the CS or video-coded frowns (exploratory analyses) (all ps > .05). Taken together, our results point to a developmental shift of infants' positive emotional perception of infant-led triadic interactions between 4 and 10 months of age. The findings underscore infants' increasingly active role in triadic interactions during the first year of life. Toward the end of the first year of life, not only triadic interactions per se, but especially infant-led triadic interaction appear to be pleasurable for infants.

S.05 Infants' neural sensitivity to caregiver ostensive signalling: has its importance been over-egged?

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Summary

Early, lab-based studies, often with low ecological validity, suggested that infants' brains are highly sensitive to communicative signals. These have led to numerous theories about how we learn to interact and acquire knowledge. However, we still know little about infants' sensitivity to social signals during free-flowing exchanges, and how they process information they receive around social signals. This symposium presents four cutting-edge and diverse approaches to studying infants' early sensitivity to ostensive signals. The first two papers examine infants' neural tracking of speech and links with speaker's gaze and caregiver-modulated semantic complexity. The second two papers examine links between perception of communicative signals and caregiver-infant inter-brain synchrony. Overall, the results of these studies converge on the provocative conclusion that infants may not be as sensitive to caregiver cues during early attention and learning exchanges as we thought.

Details

Abstract 1, Title: Does the speaker's eye gaze facilitate infants' neural tracking of speech?

Abstract 1, text: Eye gaze is a powerful ostensive social cue that has been found to facilitate children's learning in various domains of cognitive development, including language. While the language development literature mainly suggests links between gaze following and later vocabulary development, the effects of eye gaze on other aspects of language development, such as speech processing, are less clear. In this study, we examined the role of the speaker's ostensive eye gaze on 10-month-old Dutch-learning infants' neural tracking of naturalistic continuous speech, a neural marker for speech

processing, as well as their attention to the speaker. Infants watched videos of a speaker reciting stories, while 32-channel EEG was recorded throughout the experiment. In the videos, the speaker either addressed the infants with direct gaze, or averted her gaze away from the infant while speaking. We analysed infants' neural tracking of speech using speech-brain coherence (SBC), focusing especially on the stressed syllable and syllable rates (1-1.75 Hz and 2.5-3.5 Hz respectively in our stimuli). To assess whether infants tracked the speech rhythm, we first ran cluster-based permutation analyses at the stress and syllable rates by comparing real SBC to surrogate data, created by randomly pairing the speech envelope with the EEG data. Then, we tested for differences in SBC in the Direct and Averted Gaze conditions using cluster-based permutation at the frequencies of interest. Furthermore, we tested for differences in attention to the speaker's communication accompanied by Direct versus Averted Gaze, measured by both looking times and theta power. Finally, we investigated whether infants' neural tracking predicts their subsequent vocabulary development. Our results (N = 50) revealed significant SBC at both the stressed syllable and syllable rates (corrected cluster p's = .002 at both rates). However, we identified no significant differences in SBC between the Direct and Averted conditions in either frequency band. Furthermore, infants' looking times and theta power did not significantly differ between the two conditions. Regarding vocabulary development, we found that infants' syllable-rate neural tracking at 10 months predicted their expressive vocabulary size at 18-months, controlling for 10-month-vocabulary ($\beta = 0.09$, SE = 0.04, $t = 2.51$, $p = .016$). These current results suggest that infants track the stressed syllable and syllable rhythm, which is further related to their vocabulary development. The strength of neural tracking or infants' attention was not modulated by the speaker's gaze direction, suggesting that the effects of an interlocutor's eye gaze might not bring about a processing benefit in all domains of language processing.

Abstract 2, Title: 5-month-old frontocentral theta power predicts caregiver speech complexity during free-flowing parent-infant social interactions.

Abstract 2, text: Infants are powerful learners, sensitive to statistical variabilities in their environment, and capable of selectively orienting their attention towards stimuli with the maximal potential for learning (Poli et al., 2020). When adult agents interact, they need to find the balance between expressivity (novel information) and predictability (redundancy) (Woźniak et al., 2022). We know that infants are sensitive to this information trade-off (Kidd et al., 2014). However, little is known about how caregivers dynamically modulate these features to attract and maintain infant attention during naturalistic joint play.
Here, we propose that this balance is not a universally constant value but is temporally modulated by caregivers to match infants' dynamic attentional needs. We hypothesise that at times when infants are inattentive during free-flowing interactions, caregivers will create semantic uncertainty to elicit curiosity and increase infant attention and engagement. One way of indexing infants' attention at a fine timescale is to use EEG and extract the power at theta activity over fronto-central electrodes, which has been previously found to associate with infant's sustained attention (Xie et al., 2018). We recorded 5-month-old infants (N_current = 13 (data collection ongoing, N=30 at 5mo and N=30 at 10mo planned) and their English-speaking mothers via 64-channel gel-based EEG. Infant-caregiver dyads sat across a table and played "like at home" with a set of three toys. Caregiver speech was recorded at 44100Hz using a lapel-worn microphone. Oculomotor artifacts were cleaned using ICA-based procedures, tailored for naturalistic infant data (see Haresign et al., 2021). Relative theta power (3-6Hz) in the fronto-central region was extracted in 4s sliding windows with 0.5s overlap. Semantic complexity was computed based on the automatic audio-to-text transcription with precise onsets and offsets by Whisper.ai (Louradour, 2023). The text was then losslessly compressed in an integrative window in steps of 0.1s. This lossless

compression metric is an index of the amount of novel information over time, based on Kolmogorov complexity (Wolff, 2014) and assesses the speech predictability based on prior linguistic input. We then computed the derivative of that time series to obtain an instantaneous information rate, here referred to as semantic complexity. Spearman cross-correlations were run between the two, four-minute timeseries. Surrogate cross-correlations were created by assigning theta time series to other speech streams, and significance was tested using cluster-based permutation analyses, with an alpha value of p=.05 (Meyer et al., 2021).
Theta power was found to be significantly negatively correlated around 3 seconds ([-3.7s,-3.1s]) prior to semantic complexity. This can be interpreted in two complementary ways: an increase in semantic complexity 3s after a negative dip in theta power (inattentive moment), and a decrease in semantic complexity 3s after a high level of theta (attentive moment). This delayed reaction could reveal a capture-and-hold strategy from the caregivers, where they introduce uncertainty to grab back attention only to release the uncertainty when attention is back to a baseline level.

Abstract 3, Title: Gaze onsets during naturalistic infant-caregiver interaction associate with 'sender' but not 'receiver' neural responses, and do not lead to changes in inter-brain synchrony.

Abstract 3, text: In recent years our understanding of early social and communicative development has relied heavily on studying ostensive signals, defined as signals from a communicator to generate an interpretation of communicative intention in an addressee. It has been argued that, from shortly after birth, infants' brains are sensitive to ostensive signals (such as direct gaze, smiles and infant-directed vocalisations), and that 'sender' communicative signals play a key role in supporting early learning exchanges. However very little is known about exactly how this is facilitated, during free-flowing parent-infant social interactions.
Here we aimed to take initial steps in addressing this deficit. In this paper, we focus on mutual gaze, which is a widely studied ostensive signal. We extracted EEG activity around naturally occurring gaze onsets from EEG hyperscanning recordings of parent-infant social interactions in N=55 dyads (mean age 11 months). Gaze was coded from video recordings offline frame by frame at 50fps. From this we defined two types of looks onsets; sender gaze onsets were defined as times when either the adult or the infant made a gaze shift towards their partner at times when their partner was either reciprocating their gaze (mutual) or not reciprocating their gaze (non-mutual). Receiver gaze onsets were defined as times when either the adult or the infant is already looking at their partner (mutual) or not looking at their partner (non-mutual) and their partner makes a gaze shift towards them. We used inter-trial coherence (2-18 Hz, over occipital electrodes) to assess whether significant phase resetting occurred around sender and receiver gaze onsets. We also examined whether this associated with changes in interpersonal neural entrainment (measured using Phase-Locking Value and Partial Directed Coherence) between the 'sender' and 'receiver' around gaze onsets. Lastly, we compared interpersonal neural entrainment between mutual and non-mutual gaze.
We predicted that changes in phase alignment around mutual gaze onsets would occur concomitantly in the sender and receiver's brain activity. Further, mutual gaze onsets would result in more intra-brain phase resetting and greater interpersonal neural entrainment (measured using PLV and PDC, in frequencies 2-18 Hz, over occipital electrodes) than moments of non-mutual gaze.
Contrary to our hypothesis we found that, during a naturalistic interaction, both mutual and non-mutual gaze onsets were associated with changes in the sender, but not the receiver's brain activity and were not associated with increases in inter-brain synchrony above baseline. Further, we found that mutual, compared to non-mutual gaze onsets were not associated with increased inter-brain synchrony. Overall,

our results suggest that the effects of mutual gaze are strongest at the intra-brain level, in the 'sender' but not the 'receiver' of the mutual gaze.

Figure 1.

Abstract 4, Title: Behavioral and Neural Coordination in Multidimensional Caregiver-Infant Communication

Abstract 4, text: Infants learn to communicate during everyday interactions with caregivers. However, existing research underestimates the dimensionality of infants' communicative input, focusing on one or two communicative signals (e.g., speech alone, or speech and gesture together). Our goal is to investigate "infant-directed communication" (IDC): the suite of communicative signals from caregivers to infants including speech, action, gesture, emotion, and touch. Across two studies, we characterized caregivers' use of IDC during everyday interactions with infants and examined links to behavioral and neural indices of caregiver-infant synchrony.

A total of 104 caregivers and their 18- to 40-month-old toddlers participated in our studies. Families were predominantly white, middle-class families in the United States. In Study 1 (N = 44), caregivers and infants were recorded (via Zoom) during a free-play interaction in which caregivers were asked to gather a few toys and play with their infant as they normally would. In Study 2 (N = 60), caregivers and infants were invited to the lab where we simultaneously measured neural activity in the brains of caregivers and infants (using fNIRS) as they played together with familiar, unfamiliar, and novel toys. Videos of all interactions were coded for caregivers' use of each of the five dimensions of IDC (speech, action, gesture, emotion, and touch) as well as infants' vocalizations and gestures using extensively detailed and previously-validated methods.

In Study 1, we found that multiple, overlapping dimensions of infant-directed communication occurred throughout the entire interaction. Significantly more than half of the speech that infants heard (M = 64%, SD = 11%) overlapped with one or more non-speech cues ($p < .001$). Even when infants were not hearing speech, non-speech communicative cues still occurred nearly half of the time (M = 49%, SD = 15%). Further, we found that caregivers increased their use of communicative cues immediately following infants' vocalizations ($p < .02$) and gestures ($p < .001$), suggesting that caregivers respond to infants by increasing the dimensionality of their communicative signals (see Figure 1).

Analyses for Study 2 are ongoing. Initial data suggest that caregivers tune their communication to infants' familiarity with objects, using more multidimensional cues when interacting with objects that are less familiar. We are currently exploring the extent to which caregivers' use of multidimensional cues is linked to caregiver-infant neural synchrony. We anticipate that caregivers' use of multidimensional cues will lead to stronger neural coupling between caregivers and infants.

Our results demonstrate that everyday caregiver-infant communication is highly multidimensional; caregivers frequently use multiple overlapping speech and non-speech cues during everyday interactions with infants. We also find that caregivers tune their use of communicative cues to infants, increasing dimensionality of communication in response to infants' vocalizations and gestures and when objects are less familiar. In ongoing analyses, we are exploring how the dynamics of caregivers' everyday interactions with infants may support synchrony at the neural level, likely in a way that enhances learning over time. We conclude that the multidimensionality of IDC is necessary to build theories that incorporate the natural dynamics of infants' real communicative environments.

Figure 2.

S.06 Object familiarity's role in parent labelling and children's object exploration and learning, across diverse naturalistic contexts

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Summary

Natural learning environments of children consist of various real objects, presenting a simultaneous mix of objects whose names they already know, along with other unknown objects. This symposium presents new research examining parents' information-providing and children's information-seeking behaviours in various naturalistic settings that include both known and unknown objects. We (1) examine parent labelling and infant holding of known and unknown objects during 2-hour home recordings; (2) show how parents tailor the quantity and quality of language input based on infants' word knowledge; (3) examine infants' information-seeking toward known and unknown objects and measure learning outcomes; and (4) utilise a novel technology to demonstrate children's ability to learn object names actively as well as from observing others. These talks provide converging evidence across approaches, ages, and populations, demonstrating that parents and children tend to focus on already known objects.

Details

Abstract 1, Properties of Infant Known and Unknown Real Words in Mother-Infant Interactions at Home:

Language learning is a complex process. Word learners must map the words they hear to objects and events in the world. The mapping problem is not easy because any word could map to many referents. However, a growing body of research suggests that infants disambiguate meaning through their interactions with caregivers. In laboratory studies, infants learn the words for the objects they hold (Yu & Smith, 2008), and the words produced by caregivers, with input characterised by repetition and spacing (Slone et al., 2023). Do the properties of input that promote learning in the laboratory generalise to children's knowledge of words in the real world? We investigated the properties of infant known and unknown words for objects in the home environment.

Thirty-two mothers interacting at home with their 18-month-old (n = 16), or 23-month-old (n = 16) infants (16 female) were recorded for two hours. Mothers' speech and infants' object interactions (i.e., infant manipulating an object(s) by moving it in space) were coded frame-by-frame using Datavyu. Finally, mothers indicated in the MB-CDI inventory the words that infants produced. MB-CDI words that referred to concrete objects (245/682) formed the "MCDI concrete subset". Objects/words that infants touched and mothers named were classified as "known" or "unknown" based on the mother's report of infant production. Data contained sufficient instances of infant holding (*M*=32/245) and mother naming (*M*=130/682). On average mothers produced 823.7 tokens of MCDI word types.

Comparing known (*M*=79) and unknown (*M*=165) words for concrete objects, infants were more likely to manually engage with objects of known words (21%) compared to objects of unknown words, (9%), *p*=.017. Moreover, mothers were more likely to name known concrete object names (45%) relative to unknown concrete object names (20%), *p*<.001. Delving deeper into properties of mothers' speech, mothers were more likely to repeat known words (*M*=51) (74%) relative to unknown words (*M*=72) (68%), *p*<.0001. Specifically, out of the known word types that mothers produced, 76% were repeated on average; whereas out of the unknown word types that mothers produced during the interaction, 67% were repeated on average.

Finally, we compared the time-latencies between all pairs of the same MB-CDI words to examine the closeness in time of mothers' word repetitions (Figure 1). Temporal structure for mothers' naming of known and unknown words was similar (Figure 2), although a Kolmogorov-Smirnoff test detected that latencies between repeated known words were shorter than latencies between repeated unknown words (*p*<.001).

Findings align with laboratory-based studies showing the importance of infant object manipulation and mother naming for real word learning. Measures of temporal structure also showed differences, although overall patterns of latencies are the same. This study also adds to our understanding of word learning. Results are discussed in terms of the dual benefits to comparing features of known and unknown objects by: 1) informing on the properties of interactions that support language learning, and 2) identifying how caregivers and infants interact differently if infants know the words for the objects they touch.

Abstract 2, Parents' Perception of Infant Word Knowledge Influences Their Language Input to Infants:

Early vocabularies are dominated by object names (e.g., "dog," "ball,"; Bates et al., 1995). Infants begin to comprehend and produce such words through interactions with experienced speakers. Both the quantity and quality of the language input parents provide are predictive of children's later language ability and school achievement (Cartmill et al., 2013; Hurtado et al., 2008). But what determines the quantity and quality of parents' speech to infants about objects?

Previous research suggests that parents' object-naming behaviours may differ for objects whose names are familiar--versus are not yet familiar--to their infant (Cleave & Bird, 2006; Masur, 1997; Chen et al., 2002). The role of object familiarity on parent labelling behaviour is critical to better understand, given that natural word-learning contexts frequently involve both familiar and unfamiliar objects. Nevertheless, much of what we know about infants' object-name learning during parent-child interaction comes from studies employing novel objects like "wugs". We take a more naturalistic approach by examining the quantity and quality of parent naming behaviours in toy-play interactions involving *both* familiar and unfamiliar *real* objects, presented *simultaneously*.

Method. Parents and their 15-25-month-olds completed a 10-minute naturalistic play session with 23 objects (truck, elephant, flower, etc.). Each object was classified as "Familiar" or "Unfamiliar" individually for each child based on parent reports of whether their child produced ("Familiar") or did not produce ("Unfamiliar") the noun label for each object (Cleave & Bird, 2006). On average, 12 objects were classified as Familiar and 11 as Unfamiliar, for each child. Parents' speech was transcribed and coded for "naming utterances"—phrases that included an object label. Infants and parents wore head-mounted eye-trackers; recordings were coded frame-by-frame for infant and parent looks to and

touches of each object. We analysed data from 21 dyads for whether parents' perception of an object label's familiarity to their child influenced the quantity and quality of speech to their child about that object. Higher quality was indicated by naming the object the child was looking at and/or touching, and by the parent touching the object they name, all of which have been shown to promote infant object-name learning (Bion et al., 2013; Smith & Yu, 2012; Yu & Smith, 2013).

Results. Children looked to and touched Familiar and Unfamiliar objects equally frequently and for similar durations (Figure 1A-D). Nevertheless, parents named Familiar objects more frequently and with longer utterance durations (greater *quantity*) compared to Unfamiliar objects (Figure 1E-F).

Parents facilitated high-*quality* naming moments by frequently naming objects while their infant looked at them (Figure 2A). Additionally, parents often touched objects they were naming, and named objects their infants were touching, exhibiting these behaviours more frequently for Unfamiliar compared to Familiar objects (Figure 2B-C).

Discussion. In this naturalistic play context, parents adapted both speech quantity and quality based on perceived word familiarity. This adaptation may enhance learning about familiar nouns through increased language quantity and facilitate new learning about unfamiliar nouns through higher-quality naming moments. Future analyses will explore additional aspects of parent naming quality, including the semantic content of their utterances.

Abstract 3, Who's leading this? How object familiarity shapes caregiver-child joint attention and learning:

In a naturalistic environment, children are typically exposed to a range of objects they are more or less familiar with. Object novelty impacts how parents interact with and talk about the object (Chen et al., 2021), and how children handle objects (Schatz et al., 2022). Furthermore, parental input such as object labelling, and characteristics of parent-child interaction such as joint and sustained attention (when parents and children mutually direct their gaze to the same object in the immediate environment; Yu & Smith, 2013) impacts children's vocabulary size (Peters & Yu, 2020).

Against this background, the current study examines the features of parent-child interaction and parent labelling when they naturally interact with objects varying in their familiarity to the child. Furthermore, we examine how this quality of interaction influences children's learning of the labels for these objects. In particular, we investigated whether (i) parents lead more instances of joint attention when playing with novel objects relative to familiar ones, (ii) parents preferentially label novel objects relative to familiar objects and (iii) children's learning of novel word-object associations is affected by the frequency of object labelling and children's sustained attention towards the objects.

To test these predictions, we recruited 31 parent-child dyads (age range of children: 14-23 months old), who were asked to play with four different toys from a spread of eight – two familiar (e.g., cat, bus) and two novel (e.g., iguana, submarine) to the children (but familiar to the parents). We used head mounted eye-trackers for the parent, and standing video cameras to capture the eye movements of the child, and obtained gaze behaviour. Following that, we tested children's recognition of the labelled novel objects, and measured both their pointing and looking behaviour to determine their degree of novel object recognition.

We found that (i) that children overall led most instances of joint-attention – however, they led fewer instances when the object is novel compared to when it is familiar (Figure 1); and that (ii) a higher frequency of object labelling behaviour during familiar object play compared to novel object play (Figure 2). Furthermore, we found that (iii) children did not show any recognition of novel objects' names learnt;, and thus novel word-object recognition was not related to the frequency of object labelling or children's sustained attention. Our findings may provide support to the view that children are active participants in their daily interactions, which may prompt parents to follow their children during play sessions. In addition, with regards to children not showing successful novel word learning, perhaps there exists a minimum for novel object labelling opportunities and children's sustained attention to boost learning of novel words. On a broader note, our results may suggest that in specific types of daily interactions such as toy play, the goal of the parent-child interaction may be the interaction itself - and unless specified, parent-child dyads may not see learning as a critical outcome of such interactions.

Abstract 4, Dynamic discovery: Young children's word and object exploration across social partners on dual touch screens:

Infants and young children are regularly exposed to objects with varying levels of familiarity. Research indicates that from an early age, infants employ diverse strategies to learn the names of these objects. Caregivers play a crucial role by optimally providing infants with information aligned with their learning goals (Gergely & Csibra, 2009), facilitating the acquisition of novel knowledge through these social interactions. However, an expanding body of research suggests that young children are akin to little scientists, actively making choices about what, when, and from whom to learn (e.g., Piaget, 1957; Smith et al., 2018; Ruggeri et al., 2019). While young infants initially rely on simple motoric constraints to explore their environment and visual field (Smith et al., 2019), slightly older 4-year-old children develop word-object sampling strategies that become increasingly refined with age (Meder et al., 2021).

In this study, we examined whether young children (female=45, age range= 47-72 months, M=57.12 months, SD=5.18 months) use different strategies (active or passive) in interaction with a social partner, i.e., either their mother (44 dyads) or a friend (47 dyads), to recognize familiar objects relative to novel-object combinations. To test this, we developed a platform which consists of a sizable transparent touchscreen (see Figure 1) on which children and their social partner sit on opposite sides, able to see each other through the screen and interact with images of objects on screen. During the initial phase, participants viewed combinations of familiar objects (e.g., six objects per trial; dog, cow, pig, etc.), and in the subsequent phase, combinations of novel objects (e.g., six objects per trial; alien-like creatures with features such as three eyes). Participants took turns tapping on objects on the screen to hear the corresponding names (active exploration). During their partner's turn to interact with an image on the screen, they observed this action through the transparent screen and subsequently heard the label for that object (passive exploration).

After each phase of exploring familiar and novel objects, we examined whether children accurately identified the names of these objects by touching them upon hearing the corresponding label. Children touched familiar objects correctly more often than novel objects across social partners ($\chi 2$ (n=91) = 7.013, p=.008). Familiar objects were consistently identified with high accuracy (>95% correct). For novel objects, performance levels were above chance when actively exploring or observing others, but generally lower (approximately 32% correct). Detailed analyses revealed better recognition of novel object names when actively initiating the naming process in the first half (p=.039), which was primarily driven by interactions among children (p=.004). In the second half, better performance was observed

when children observed their partner initiating the naming of a novel object on the screen (p=.047). Children employed both active exploration and observation of others' actions when interacting with familiar and novel objects. Active exploration of novel word-object pairs led to better recognition in the presence of same-aged peers, suggesting that children rely more on personal exploration, possibly due to expecting limited educational value from peers of the same age.

S.07 The role of contingency in learning and development

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Summary

How do social interactions create learning opportunities? We know that social interaction facilitates many aspects of cognitive development. Infants learn language sooner and develop better self-regulation abilities if their parents interact with them more often. What remains unclear are the mechanisms underlying this facilitative effect. Our symposium will address this gap.

We focus on a crucial component of social interactions, *contingency*, characterized by a pattern of tight temporal coordination between two or more actors. Our papers will integrate evidence on the role of contingency in learning across methods: behavioral (paper 1), neural (paper 2), interventional (paper 3), and computational (paper 4). Our discussant, an internationally recognized expert in social interaction and learning, will illustrate and compare the diverse set of theoretical perspectives represented by the papers, and will highlight the most urgent questions and new directions for future research.

Details

Abstract 1

Abstract 1 Title: Why does social contingency predict early vocabulary development?

Abstract 1 text: We investigated the role of socially contingent interactions between typically developing infants and their parents in early vocabulary development. Convergent evidence from prior research shows that infants of parents are more likely to engage in socially contingent interactions with their infants tend to have larger vocabularies. An open question is how social contingency facilitates vocabulary growth.

One possibility is that parents who speak in response to their infants more often produce larger *amount* of language input, which could accelerate vocabulary growth. Another possibility is that the *properties of socially contingent language input* are uniquely suitable to support early word learning. Yet another possibility is that the *frequency* of parents' contingent responses helps infants build a link between their own words or vocalizations and others' behaviors, which enables infants to infer the communicative nature of language. This inference then leads to further language advances, including vocabulary growth.

To distinguish between these hypotheses, we analyzed relations between parent-infant interactions when infants were 9 and 12 months and their vocabulary size at 12 months. We analyzed *N*=23 20-minute-long video-recordings of naturalistic parent-infant interactions (the Rollins corpus), annotating every verbal and non-verbal behavior of the parent and the infant. Our findings indicate that the frequency of both verbal and non-verbal responses to infants' vocalizations predict vocabulary development longitudinally (see Tables 1 & 2, Figure 1). Our findings also suggest that this development is unlikely to be due to the amount of language input or the properties of language within socially contingent interactions at 9 months – neither variable predicts infants' vocabulary at 12 months.

Furthermore, our follow-up analyses explored the possibility of socially contingent responses guiding infants' attention to objects. We evaluated the predictive relation between parents' contingent responses to infants' vocalizations and infants' sustained attention to objects that were labeled or manipulated. While the frequency of parents' socially contingent responses did significantly predict infants' sustained attention both concurrently and longitudinally, this effect did not mediate the relation between the frequency of parents' socially contingent responses and infants' vocabulary. Infants' sustained attention did not predict infants' vocabulary concurrently or longitudinally.

In sum, our findings suggest that the frequency of parents' socially contingent responses predict infants' vocabulary size. Given the lack of significant effects of the amount or properties of language input, as well as attention, on infants' vocabulary, it remains a possibility that the frequency of socially contingent responses influences vocabulary by helping them build a communicative understanding of language. Follow-up work tests this hypothesis explicitly in an experimental setup to see whether contingent responses indeed help infants infer the communicative nature of language and how this inference facilitates vocabulary growth.

Abstract 2

Abstract 2 title: Infants' interests and speakers' social contingency jointly support infant word learning during play

Abstract 2 text: Introduction: Early language learning is a social enterprise: to learn the particular set of sounds, words and syntactic rules that make up their native language, learners depend on information that can only be communicated to them by expert speakers. Yet, this does not mean that learners are passively waiting for information: they can also actively prompt their social partners to adjust their speech as a function of what they do. Despite this, most research on language acquisition so far has focused on how infants perceive, memorise and interpret the information directed to them by expert speakers.

Here, we explore how infants' own interests shape their language acquisition. We hypothesised that infants' decisions to visually explore a specific object signal focal increases in attention, and that, when caregivers respond to these manifestations of interest by naming the object, this boosts word learning.

Methods: To examine this, we invited N=38 caregivers and their 14-month-old infants to play with novel objects, while we recorded dyadic EEG and micro-level gaze behaviours with high-resolution cameras. Following this play phase, infants' knowledge of the word-object mappings was immediately tested during a short test phase using a live adaptation of the looking-while-listening procedure. This alternation of paired play and test phases was repeated up to 8 times with different pairs of objects.

Results: Infants' proactive looks towards an object during play signal enhanced interest, as evidenced through a greater Nc/P400 ERP response around looks that were initiated by infants as compared to looks that resulted from following their caregivers' focus of interest. In sum, infant word learning was fostered when caregivers tended to join their infants' focus of attention while naming the object (beta = 0.328, se = 0.13, t = 2.4, p = 0.02); whereas redirecting the infant's attention to an object that the adult already focused on (beta = -0.49, se = 0.17, t = 2.82, p = 0.006), or naming a novel object while looking elsewhere (beta = -0.81, se = 0.04, t = 2.02, $p < 0.05$), associated with worse learning.

Discussion: We examined whether caregivers tend to name novel objects contingently on infants' interest during free-flowing play, whether this associates with better infant word learning, and whether this is related to the fact that naming objects contingent on infants' interests ensures that novel information is presented to them when they are maximally attentive. Overall, our findings are compatible with the idea that infants' increased interest when they visually explore novel objects can boost their learning of the objects' names. However, this is only true when speakers are sensitive to these manifestations of interest, and respond to them by following their infants focus of interest and naming objects contingently. Overall, our findings demonstrate the feasibility of studying word learning in realistic, interactive settings, and support the idea that infants' interests guide their acquisition of a lexicon.

Abstract 3

Abstract 3 title: From pre-linguistic communication to early language use: The role of social contingency

Abstract 3 text: Child language is built on the foundation of communicative abilities that typically emerge in the first year of life, in particular pre-linguistic acts that appear intentional on the part of the infant (e.g., babbling while gaze-checking a caregiver, pointing, showing and giving). Outstanding theoretical questions concern a) the learning mechanisms shaping the development of these 'intentional' pre-linguistic abilities, and b) their relation to later language. Drawing upon data from an ongoing RCT, we address two such conceptual questions.

First, what are the mechanisms shaping the development of intentional pre-linguistic communication? Caregiver responsiveness is thought to be a key mechanism shaping language development, but it is unclear whether it influences infants' intentional pre-linguistic communication to the same extent. Our aim was to test whether an early communication intervention would influence caregiver responsiveness and thereby promote infant pre-linguistic communication prior to the onset of spoken language (at 12 months). When their infants were around 6 months, 435 socioeconomically-diverse caregivers were randomly assigned to either a language intervention (n = 218) or an active control intervention (n = 217). Three times a month, for 18 months, caregivers received text messages containing links to online video resources. Videos focussed on caregiver linguistic responsiveness in the language intervention condition and physical health in the active control condition. When infants were 12 months old, 133 caregivers (65 language intervention, 68 active control intervention) recorded 5-minute videos of them and their child interacting at home. These were analysed for infant pre-linguistic acts and caregiver responses to these acts. Pre-registered analyses revealed a significant increase in the frequency of infants' intentional prelinguistic communicative acts and caregivers' semantically contingent responses. Thus, an

intervention to promote caregiver responsiveness had a causal effect on prelinguistic behaviours that form a key stepping stone to language.

Second, what early-occurring sequences of interactive behaviour best predict later vocabulary outcomes? While there is robust evidence that infant prelinguistic acts and caregiver talk separately predict later child vocabulary, recent exploratory work suggests that, around children's first birthdays, the strongest predictor of vocabulary growth over the second year is the dyadic combination of intentional infant communication (vocal and gestural) with a prompt, relevant caregiver responses. Our aim was to use the above-mentioned dataset to test the hypotheses generated by prior exploratory work with a new sample, and furthermore pinpoint whether semantically related responses supported language beyond prompt vocal responses alone. Using vocabulary outcome data collected when infants were 17 months, we compared the relative predictive value for later vocabulary outcomes of infant communication measured at 12 months, and of different dyadic combinations of infant communication and caregivers' response. In line with our pre-registered predictions, receiving a response to communication facilitated vocabulary development. However, in contrast to our predictions, responses without semantically relevant content were the strongest predictors of later vocabulary, suggesting that, at least in this socioeconomically-diverse sample, the promptness of caregiver responses may be especially important for supporting expressive vocabulary regardless of semantic content.

Abstract 4

Abstract 4 title: Automatic coding of contingency in early child-caregiver conversations: Towards a large-scale investigation

Abstract 4 text: Contingency is one of the most important skills children need to develop to be able to communicate with people around them. Part of this skill relies on the ability to coordinate the *timing* of one's conversational moves (e.g., turn-taking). Another part – which I study here – relies on the ability to contribute to the interaction with relevant *content*. This latter aspect is the glue that makes conversation different from a "succession of disconnected remarks" (Grice, 1975) or "collective monologues" (Piaget, 1926).

I will consider two main aspects of content contingency that children have to learn. The first concerns the ability to follow the broad structure of a conversation. Indeed, conversations are typically structured into units of communication called adjacency pairs (Schegloff et al., 1973). For example, children need to know that a question should be followed by an answer and that a request should be followed by acceptance or refusal. A second – but related – aspect is topic continuity. Indeed, contingency requires not only using the right category (e.g., a response to a question) but also the relevant words (e.g., the response should engage with the question being asked).

While both aspects have been studied in the developmental literature (e.g., Bloom et al., 1976; Keenan and Klein, 1975; Abbot-Smith et al., 2023), our current knowledge is typically based on small-scale studies. Social interaction, however, can be highly variable and context-sensitive, and drawing general developmental patterns requires an investigation at a much larger scale and across a wide variety of contexts. The challenge is that measuring conversational contingency in naturalistic data requires labor-intensive annotation, which is prohibitively expensive to deploy at scale.

I will show that recent advances in Natural Language Processing can help us overcome this challenge through automation:

- For measuring adjacency pairs, the crucial step is automatically mapping utterances to their speech act categories. To this end, our model – inspired by state-of-the-art literature on speech act detection in adult dialog systems – was trained/tested on the New England corpus (Snow et al., 1996), which was (manually) annotated with a child-appropriate coding scheme called the Inventory of Communicative Acts Abridged (INCA-A, Ninio et al., 1994).

- For topic continuity, we similarly turned to state-of-the-art modeling in dialog systems and used a pre-trained transformer neural network based on BERT (Delvin et al., 2019). We fine-tuned this pre-trained model on a set of utterances from the New England Coprus, which we manually annotated for contingency.

Both models achieved near-human-level inter-rater reliability. Next, we used them to automatically annotate the entire English-language subset of CHILDES (MacWhinney, 2000), for children aged 14 to 32 months old. The automatic annotation showed that several patterns regarding the emergence of dependency structure and topic continuity – previously obtained with small-scale studies – are robust to a much larger sample size (10 to 100 times larger) and a diverse set of children and conversational contexts.

S.08 Examining the socioemotional dynamics of early language learning

Elise Breitfeld [1], **Monica Ellwood-Lowe** [2], **Mira Nencheva** [3], **Madeleine Bruce** [4]

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Summary

In children's lives, language and emotion unfold in parallel. This symposium uses diverse methods to explore how socioemotional dynamics impact language learning. Paper 1 reveals that high arousal and positive affect support word learning and communication in a natural language sample. Paper 2 demonstrates that toddlers learn words better from individuals they have had more positive social experience with. Paper 3 presents a developmental pathway linking parental socioemotional factors to infants' language. Paper 4 uncovers unique family-level patterns in these links between life circumstances, parent affect, and language. Together, these studies present a nuanced view of the role of affect in language learning. For example, Papers 1 and 2 suggest that positive affect supports language, while Paper 4 reveals that some parents use more language with negative affect. Across timescales from one-off interactions to years (Paper 3), the socioemotional landscape impacts children's language.

Details

Abstract 1, Natural dynamics of caregiver-child affect are linked to communication and children's word knowledge: Children learn language in the context of rich social interactions that unfold in parallel

with continuous emotional experiences. Emotions are highly dynamic (Thornton & Tamir, 2017; Nencheva et al, Preprint), fill 90% of waking hours (Trampe et al., 2015), and affect memory (Hannah & Stevens, 2013), learning (Singh et al., 2004) and communication (daSilva et al., 2021; Fields-Olivieri et al., 2020). Yet, we know little about how fluctuations in affect relate to word learning and communication in real-world contexts. In a two-part investigation, we examined how caregiver-child affect relates to (1) children's word knowledge, (2) the quality of communication.

In a new, densely sampled corpus with caregiver-child dyads (24-30mo), each dyad contributed two day-long audio LENA recordings, 13 daily reports of caregiver's own affect and their perceptions of their child's affect, and a vocabulary questionnaire (MCDI; Fenson, 2007). Affect was measured in terms of valence (positive vs. negative) and arousal (high vs. low energy). These data were collected from a preregistered sample of 25 dyads. Affect-related measures were z-scored by participant, making their values relative to the dyad's average state.

In **Study 1** we investigated whether the affective contexts in which children hear words relate to children's knowledge of those words. We marked which words from the MCDI questionnaire were used by the caregiver in the 5 minutes before and after each affect survey. This resulted in 14,553 instances spread across 657 words. For each participant, we computed the proportion of instances that each word occurred in four quadrants based on the child's affect: higher vs. lower arousal, and higher vs. lower valence. A logistic mixed-effects regression showed that the proportion of word tokens occurring in positive or higher arousal contexts was positively associated with children's knowledge of the word – controlling for overall frequency (Fig.1). Additionally, the proportion of instances in lower-arousal, lower-valence contexts was negatively associated with knowledge of the word. This finding suggests that emotion dynamics – both valence and arousal – are a key factor in understanding children's word learning.

One way that positive or high arousal contexts may support word learning is by improving the quality of caregiver-child communication. **Study 2** extracted automated count estimates from LENA recordings of adult words, child vocalizations, and conversational turns spanning the 15 minutes before and after each affect survey. Caregiver and child arousal were positively associated with all three communication measures, and valence had smaller but similar effects (Fig.2). That is, periods of positive affect or high arousal were associated with richer communication, whereas negative, low-arousal periods contained less speech and turn-taking.

In a mediation analysis, we found that conversational-turn counts partially mediated the relation between affect and word production, suggesting that moments of positive valence or high arousal support word learning in part by providing richer communication.

This investigation expands the definition of word-learning contexts to include the internal affective states of caregivers and children and the communicative behaviors associated with them. Together, these studies underscore the value of looking beyond linguistic communication to understand how children learn language.

Abstract 2, Toddlers' prior social experience with speakers influences word learning: Why are some word-learning moments more effective than others? One factor is that young children prefer, and retain

more information from, familiar social partners, such as their mothers, or teachers (e.g., Corriveau & Harris, 2009; Kinzler et al., 2011; van Rooijen et al., 2019). However, the factors that drive children's affinity for learning from familiar social partners remain understudied. Existing literature has largely focused on differences in learning as the result of the quantity of prior experience children have with different people. The current work takes a novel approach by examining effects of quality of prior experiences, while controlling for the amount of experience. Specifically, we tested the hypothesis that children learn more from social partners who, in the past, behaved in ways that are engaging and beneficial to learning.

Toddlers (27-29 months, N=40) were taught labels for novel objects by two experimenters. Prior to word learning, toddlers watched pre-recorded videos of one experimenter behaving in an engaging way (i.e., using infant-directed speech, gestures, eye contact, and positive affect) and one experimenter behaving in an unengaging way (i.e., using adult-directed speech, no gestures, no eye contact, and neutral affect). Both experimenters were equally engaging during the word learning phase. Word learning was then tested using a looking-while-listening paradigm (Figure 1A). This design allowed us to equate the quantity of toddlers' previous experience with each speaker while manipulating the quality of those previous experiences (counterbalanced across participants).

The results were consistent with our hypothesis. On trials testing words taught by the previously-engaging experimenter (Engaged trials), toddlers fixated the target object significantly above chance ($b=0.09$, $F(1,38.12)=15.99$, $p<.001$). However, on trials testing words taught by the previously-unengaging experimenter (Unengaged trials), toddlers did not fixate the target object above chance ($b=0.03$, $F(1,38.00)=1.22$, $p=0.28$). Average accuracy across the critical window (300-1800ms after target-word onset) was marginally significantly different between trial types ($b=0.06$, $F(1,38.10)=3.63$, $p=0.064$, Figure 1B). Two exploratory analyses provided converging evidence suggesting better learning from the previously-engaging experimenter. A cluster-based permutation analysis revealed a significant difference in accuracy between Engaged and Unengaged trials from 667-1033ms ($t=67.92$, $p=0.05$, Figure 1C). A growth curve analysis revealed that toddlers' accuracy in fixating the target object was greater ($b=0.24$, $t=2.06$, $p=.039$) and increased more quickly on Engaged trials than Unengaged trials ($b=-0.54$, $t=1.95$, $p=.051$). These data support our conclusion that previous experience with an engaging social partner facilitates word learning.

The results highlight the importance of examining the broader social context in which word learning is embedded. The ways that adults interact with children can be determined by a wide variety of factors, including their relationship with the child, their mental health status, and their cultural community, and this variability may help to explain why some word learning moments are more effective than others.

Abstract 3, Perinatal predictors of language development: Exploring the association between maternal emotion dysregulation and infant vocabulary acquisition: Language emerges in the context of social interactions as infants rely on caregivers for exposure to rich and diverse speech (Weisleder & Fernald, 2013). Mothers endorsing symptoms of depression have been shown to produce less contingent, infant-directed speech, which is thought to have downstream effects on infant language (Lam-Cassettari et al., 2020). The existing literature has largely focused on broad, diagnostic categories of psychopathology (e.g., maternal depression), which limits our understanding of the transdiagnostic markers of maternal dysfunction evident during prenatal development. Additionally, few studies have identified 1) the

mechanisms underlying the relation between maternal psychopathology and infant language development, and 2) modifiable protective factors that may mitigate infant risk for poor language outcomes. Thus, the current study sought to address the following questions: First, does maternal emotion dysregulation during pregnancy predict infant language via maternal life stress measured during the first postnatal year? Second, does maternal mindfulness during pregnancy moderate this developmental pathway? In other words, does prenatal mindfulness protect against adverse language outcomes among children of dysregulated mothers?

Data were collected from 385 mother-infant dyads (51.7% female) who participated in a longitudinal study spanning pregnancy through 18-months postpartum. During the prenatal lab visit, expectant mothers completed self-report measures assessing their emotion dysregulation (Difficulties in Emotion Regulation Scale; Gratz & Roemer, 2004) and their mindfulness during pregnancy (Mindful Attention and Awareness Scale; Brown & Ryan, 2003). At 7-months, mothers' stress levels were assessed across five domains using the Everyday Stress Index (Hall et al., 1985): Role overload, financial concerns, parenting worries, employment problems, and interpersonal conflict. At 18-months, mothers reported their infants expressive and receptive vocabulary size using the MacArthur-Bates Communicative Development Inventories (Fenson et al., 2007).

Descriptive statistics and correlations are reported in Table 1. Path analysis was used to examine the relations between perinatal maternal factors and infant language outcomes, and acceptable model fit was achieved, $\chi2(12)=21.41$, $p=0.04$; RMSEA=0.05, SRMR=0.06, CFI=0.91 (Figure 1). Expectant mothers who reported greater emotion dysregulation experienced higher levels of everyday stress at 7-months postpartum ($\beta=0.19$, $p=0.05$). This relation was not moderated by maternal mindfulness during pregnancy; rather, maternal mindfulness exerted a direct effect on mothers' stress levels at 7-months ($\beta=-0.23$, $p=0.01$). Additionally, mothers reporting high stress levels at 7-months had toddlers with smaller expressive vocabularies at 18-months ($\beta=-0.18$, $p=0.02$). Finally, mothers' postpartum stress level emerged as a mechanism through which both prenatal emotional dysregulation and mindfulness during pregnancy indirectly influenced infant expressive vocabulary ($\beta=-0.03$, SE=0.02, 95% CI [-0.096,-0.002] and $\beta=0.04$, SE=0.02, 95% CI [0.005,0.103], respectively). This study uncovers a novel developmental pathway through which perinatal risk and protective factors predict infant language development. Our findings suggest that interventions targeting maternal mindfulness and emotion regulation during pregnancy may reduce mothers' everyday stress levels during the postpartum period, which may in turn promote expressive language development in infancy.

Abstract 4, Happy talkers, sad talkers: Heterogeneity in caregivers' day-to-day affect and child-directed speech: Variability in parents' speech with their children (child-directed speech, CDS) contributes to individual differences in children's vocabulary development. But what explains variability in CDS? Research points to caregivers' affect as a potential driver of differences in CDS, suggesting that caregivers may talk more with their children when feeling more positive, or more aroused. However, much of this research has been confounded by context—some contexts may elicit both more affective arousal and more CDS. A consistent daily context is needed to isolate the factors that influence parents' affect, and to test whether these day-to-day shifts in affect in turn influence CDS. We had two main questions. First, what factors are related to parents feeling more positive and less negative in the same, child-centered context—children's bath times—each day? Second, how do these same experiences relate to parents' CDS quantity during bath time?

We took an experience sampling approach, asking socioeconomically-diverse English-speaking American caregivers to audio-record an interaction with their child—their bath time—each day, for 20-60 days. Caregivers also filled out a daily survey that captured their positive and negative affect (using the PANAS scale), worries, sleep, and how they spent their time that day, and any financial assistance received (e.g., government stimulus check). Finally, family-level variables were linked with national daily data related to the pandemic (e.g., COVID cases). Children ranged in age from 18-26 months at study start. Here, we analyze 41 families with complete survey data for more than 20 days; additionally, we analyze an initial 19 families for whom 733 bath time recordings have been transcribed and coded (Mage=21.62mo.; Mrecording duration=18.88min.). We performed separate cross-validated ridge regressions for each family, to explore which variables explain variability in (1) parents' positive and negative affect, and (2) their speech to their children. These analyses deal well with multi-collinearity. Finally, we performed community detection network analyses to identify clusters of families who shared similar predictors of affect and CDS.

Commonalities in predictors of affect. We found that most parents feel more positive and less negative with more sleep, leisure time, and increasing nation-wide vaccinations, and when feeling less worried (ps<.05). Cluster analyses revealed that these effects were generally consistent across families.
Divergent predictors of CDS. In contrast, we found considerable heterogeneity in factors that relate to parents' CDS (Figure 1). We identified three clusters of families (Figure 2): (1) a group that talks more when feeling more positive and less negative, in line with prior research (N=7); (2) a group that talks more when feeling more neutral (i.e., less positive and less negative; N=8); and (3) a group that talks more when feeling more negative (i.e., more negative and more worried; N=3).

Our analyses reveal that parents' language is sensitive to shifts in their day-to-day experiences, but also that the factors parents are most sensitive to vary across families. In addition, our analyses offer unique insight into the factors that confer risks versus benefits for parents' mental health.

S.09 The bodily self in typical development and in visually impaired and motor impaired contexts

Francesca Garbarini [1], **David Lewkowicz** [2], **Andrew Bremner** [3], **Monica Gori** [4]

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Summary

This symposium deals with bodily self-representation in typical and atypical development. In the first talk, Andy Bremner will address typical development, presenting electrophysiological evidence of the multisensory foundations of body representations in the first year of life. The second and third talks will address atypical development in two deprivation models. Monica Gori will discuss the crossmodal impact of visual experience on early somatosensory and auditory processing, via behavioral and electrophysiological evidence in visually impaired and sighted infants. Francesca Garbarini will discuss the role of motor experience in shaping the multisensory representation of the bodily self in space, via evidence from congenital and acquired motor deprivation. The symposium will demonstrate the role of

early crossmodal interactions in the developing bodily self with David Lewkowicz discussing the research in the context of the wider literature on multisensory development.

Details

Abstract 1, Development of the multisensory foundations of body representations in the first year of life: A role of tactile-visual crossmodal attention

Introduction
As adults, we typically possess an ability to orient attention between different (and often fleeting) sensory cues ("crossmodal attention"). Despite considerable research into the early development of multisensory perception, including selective attention to multisensory stimuli, we know little about early abilities to coordinate selective attentional shifts between different sense modalities. This ability may play a crucial role in sensing and learning about the bodily self, e.g., enabling infants to spatially orient their attention to visually or auditorily process an object that has given rise to a tactile sensation (e.g., the unexpected brush of a surface as the hand moves past it). Here we report the findings of a study in which we investigated tactile to visual crossmodal links in covert spatial attention using event-related potentials (ERP) with 5- and 7-month-old infants.

Hypotheses
Whilst evidence indicates that exogenous cuing of covert spatial attention in vision is established by 5 months of age, no studies of which we know have yet examined crossmodal cuing effects between the senses (e.g., the cuing of faster orienting to or greater processing of a visual stimulus by a prior tactile cue). However, because studies of overt crossmodal visual orienting responses to tactile stimuli develops in the second half of the first year, we predicted that we would find evidence of crossmodal tactile cuing of visual attention in older (7-month-old), but not younger (5-month-old) infants.

Study population
The 5-month-old group of infants (n=19, 12 female) were aged on average 21.77 weeks (SD = 1.68 weeks, range: 19.14-24 weeks). The 7-month-old group of infants (n-19, 10 female) were aged on average 32.4 weeks (SD = 1.26 weeks, range: 30.14-36 weeks). Infants were recruited from a database of participants of mixed but predominantly Caucasian ethnicity.

Methods
Trials from three conditions were presented (Fig. 1A). In all, a vibrotactile cue on one hand was presented, followed after 150 ms by either: i) a visual probe on the same hand (Congruent condition), ii) on the opposite hand (Incongruent condition), or iii) by no visual probe (No Probe condition). The No-Probe trials were included as a control to ensure that any effects of condition on EEG responses to the visual probe were not influenced by purely somatosensory activity propagating to visual electrodes (see EEG Recording and Analyses). We recorded the infants' brain activity throughout the study using electroencephalography (EEG) and analysed the visual evoked potentials (VEPs) measured in response to the visual stimuli. We calculated a difference waveform between the trials with and without the visual probe to measure and compare purely the visual responses and ensure that the tactile influences common across all trials, were removed by the subtraction. We then compared the difference waveforms for the Congruent vs the Incongruent conditions.

Results
The 7-, but not the 5-month-old infants showed evidence of the influence of a prior tactile cue on processing of a subsequent visual stimulus presented at the same location (Fig. 1B/C). This suggests that crossmodal spatial attention between touch and vision undergoes development across the first year.

Abstract 2, Shaping Perception: Unraveling the Influence of Visual Experience on Early Somatosensory Remapping

Introduction
Perceiving our body and its boundaries is crucial for developing everyday skills. However, appropriately integrating all sensory inputs concerning the body and external space is a significant computational challenge, particularly when the sense organs move with respect to each other. For instance, when the hands move into a non-canonical crossed-hands posture, adults rapidly locate a touch to the hand resting where the touch would have been in a canonical uncrossed-hands posture, but then remap the touch to locate it on the hand where it occurred: “somatosensory remapping”, a process which is observable in infant behavioral and neural responses from 10 months of age. Here, we report the findings of a study of somatosensory remapping in the brain and behavior in severely visually impaired (SVI) compared to sighted (S) infants.

Hypotheses
We investigated the hypothesis that visual experience in infancy underpins the developmental construction of somatosensory spatial representation and remapping.

Study population
The experiment was performed in 11 sighted (S) and 11 severely visually impaired (SVI) infants between 5 and 36 months.

Methods
We measured behavioral orienting responses and event-related potentials (ERPs) in response to auditory and tactile stimuli, comparing these across uncrossed- and crossed-hands posture conditions. Thus, four different stimulus conditions (Tactile Uncrossed / Tactile Crossed / Auditory Uncrossed / Auditory Crossed) were presented across 6 blocks of trials, with 12 trials in each condition, and a maximum of 48 trials overall. Brain electrical activity was recorded continuously using a Hydrocel Geodesic Sensor Net, consisting of 128 silver–silver chloride electrodes evenly distributed across the scalp. The vertex served as the reference during the recording. In the infants’ behavioral responses to each stimulus, the direction and type (hand, head) of the infants’ first orienting responses to the stimuli on each trial were coded from the video records by two raters naive to the purpose of the study, and blind to the site of the stimulus.

Results
Comparing S and SVI infants, our findings confirm the role of visual experience in mediating tactile but not auditory brain processes in external space. Our behavioral results confirmed our previous findings (Gori et al., 2021). ERP responses to auditory stimuli did not differ between groups and were not modulated by limb position in either group. For somatosensory responses, SVI infants showed a heightened contralateral somatosensory response in the crossed-hands posture, which correlated with the direction of their behavioral orienting responses. This response is more pronounced in SVI infants than their sighted counterparts during the early time window. In contrast, sighted infants exhibit a later

modulation of the ipsilateral somatosensory response by posture, which correlates with their behavioral reactions. This suggests that SVI children stay anchored to body coordinates in the early years, while sighted children shift towards an external reference space, revealing a two-step somatosensory processing mechanism. These findings underscore the existence of a specific temporal hierarchy that is behaviorally relevant in the impact of vision on somatosensory processing, emphasizing its role in the early stages of life.

Abstract 3, The role of early motor experiences in shaping multisensory representation of the bodily self in space: evidence from acquired and congenital sensorimotor deprivation

Introduction
Spatially organized multisensory integration (MSI) is considered a hallmark of the bodily-self representation in space. While influential studies investigated the role of visual deprivation in shaping this representation, less attention has been paid to motor deprivation. Electrophysiological studies in non-human primates show that multimodal neurons encode multisensory bodily stimuli in body-centred reference frames by anchoring visual, auditory and tactile receptive fields to a given body part by means of proprioceptive inputs. Thereby, the motor context seems to play a crucial role in shaping this mechanism. Here, to challenge the idea that early motor experience is the typical developmental context that allows the emergence of multisensory representation of body effectors, we exploited the atypical development of hemiplegic children with cerebral palsy (CP). In this population, the deprivation of hand movements since birth should have prevented proprioceptive input to anchor multisensory stimuli in a hand-centered reference frame, thus leading to an altered multisensory representation of the affected hand in space.

Hypotheses
We formulated our hypotheses on the comparison between acquired and congenital motor deprivation. While individuals with acquired motor deprivation should show a spatially organized multisensory integration due to their previous motor experiences, we anticipated that CP children with congenital motor deprivation should not, since multisensory stimuli have not been anchored to proprioceptive inputs through development.

Study population
Post-stroke patients with acquired upper-limb hemiplegia (N=11; 6 females; 8 right-brain damage; 55.2±13.8 years).
CP children with congenital upper-limb hemiplegia (N=4; 1 female, 3 right-brain damage; 10.7±2.2 years). Two groups of 20 controls age-matched to acquired (12 females; 63.2±16.1 years) and congenital (10 females; 13.5±5.3 years) populations. For the ICIS 2024, we plan to acquire 20 hemiplegic patients and 20 CP children.

Methods
Participants were asked to provide speeded responses to tactile stimulation on their left or right hand (in different sessions) which could be delivered alone (T-trials) or concomitantly with a visual stimulus (VT-trials). Faster reaction times (RTs) to bimodal (VT) than unimodal (T) stimuli should show a MSI facilitation. To test a spatially organized MSI (body-proximity effect), we manipulated the proximity of the visual stimulus to the hand by leveraging a postural manipulation where the hand was passively

Back to top

moved either near or far from the visual stimulus. Faster RTs to bimodal Near than Far stimuli should show a body-proximity effect.

Results
Patients with acquired motor deprivation showed, in both intact and affected sides, a body-proximity effect (significantly greater MSI facilitation in Near than in Far conditions) comparable to that found in their controls. CP children with congenital motor deprivation showed a body-proximity effect comparable to their controls only in the intact side, while no difference between Near and Far conditions was present in the affected side. These preliminary results, if confirmed in the whole sample, may suggest that early motor experiences play a crucial role in shaping multisensory representation of the bodily-self in space. From a clinical perspective, this can also promote new rehabilitation interventions focusing on body representation deficits in CP children and on their interaction with functional outcomes.

S.10 Novel Approaches and Insights into the Psychophysiological Underpinnings of Social Development

Julia Yurkovic-Harding [1], **Drew Abney** [2], **Jeremy Borjon** [3], **Mitsuhiko Ishikawa** [4]

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Summary

Infant physiological regulation is predictive of later social and emotional development. However, little is known about how moment-by-moment changes in infant physiology support the infant's production of social behaviors or engagement with the parent. Elucidating the mechanistic role of physiology on social development requires the development of fine-grained measures of physiology. The goal of the current symposium is to present four talks that employ distinct and innovative measures of infant physiology and focuses on a different social behavioral outcome (i.e., smiling, vocalization) in a different age group (ranging from 3- to 25-month-olds). The ensuing discussion (led by all presenting authors) will focus on how physiological theory informs methods, as well as the validity of these new methods. Each talk found significant relationships between infant physiology and concurrent social behavior, and the implications for future research will also be discussed.

Details

Abstract 1: Dynamics of RSA Reveal differences in Physiology Surrounding Social Smiles for Infants at Elevated- and Low-Likelihood for ASD

Introduction. Respiratory sinus arrhythmia (RSA) is an index of physiological regulation that measures fluctuation in heart rate as a function of breathing rate (Richards, 1985, 1987). High RSA supports concurrent stimulus engagement (Richards & Casey, 1992) and is predictive of later social abilities (Mateus et al., 2018). Evidence suggests that RSA in children with autism spectrum disorder (ASD) is atypical and precedes the social difficulties that characterize the disorder (Patriquin et al., 2013). Despite its potential as an early mechanism of social development, RSA has not been studied in young infants with ASD. We therefore aim to understand changes in RSA surrounding social smiling, the first social behavior to emerge in infancy (Lavelli & Fogel, 2005). Infants smile in response to their parent and elicit

further social behaviors from the parent (Symons & Moran, 1994), thereby laying the foundation for reciprocal social communication.

Participants and Study**.** Participants are 81 infants at elevated likelihood (EL, n=28) or low likelihood (LL, n=53) for ASD who were part of a longitudinal study. Data from 3- and 4-month visits (n=113) were included. Dyads engaged in face-to-face play for 5 minutes while infants wore heart rate monitors. Moments of social smiling were identified by the infant both looking to and smiling at the parent. Interbeat intervals (IBIs) were identified from the raw heart rate data.

RSA Analysis**.** Predominant theories of RSA differ in their interpretation of RSA as either a tonic phenomenon that should be evaluated over long timescales or a phasic phenomenon that should be evaluated at the same timescale as respiration. Extant measures built on tonic theories are only validated for dynamics occurring across >15s windows (Abney et al., 2021). However, these windows of time may be too coarse to capture RSA related to social smiles, which are ~3.5s long and temporally coupled with looks at ~4s latencies (Yurkovic-Harding & Bradshaw, *Under Review*). The current study therefore leverages continuous wavelet transforms to calculate RSA, which are valid for dynamics at 2s, thereby coordinating with the phase of infant respiration. (Richards et al., *In Prep).* A significant portion of this talk will validate this innovative analysis.

Results**.** RSA across the full session did not differ as a function of age, group, or age x group (all p>.09). We next calculated change in RSA preceding and following social smiles. We fit a linear model to the age x group means and used a bootstrap analysis to compare intercepts and slopes (Figure 1a). 3mo LL infants had a significantly lower levels of RSA before smile onset compared to 4mo LL infants (p<.05). Additionally, 3mo LL infant RSA increased more quickly than both 3mo EL infants (p<.05) and 4mo LL infants (p=.01). There were no differences in RSA during smiles (all p>.07) or in the dynamics of RSA following smile offset (all p>.07).

Discussion**.** The physiological systems of 3mo LL infants appear to coordinate with and support the onset of social behaviors. This was not the case for 3mo EL infants or 4mo infants. Increased physiological regulation in 3mo LL infants may reflect engagement with the parent and may lead to deeper processing of the social interaction (Richards & Casey, 1992). An absence of this effect in EL infants may suggest that, while they are able to engage in social interactions, they may not be as fully physiologically engaged with them. This coincides with recent findings that the temporal dynamics of looking and smiling differ in EL relative to LL infants (Yurkovic-Harding & Bradshaw, *Under Review*). Future work will aim to predict social communication outcomes from the relationship between RSA and smiling in both groups.

Abstract 2: Infants' physiological dynamics are elevated during long bouts of mutual positive engagement with their mothers

The ability of human infants to dynamically adapt their physiological states to changing social demands is critical for the development of emotion regulation. While decades of research have demonstrated that infants' physiological states can be adaptive to changing environmental demands and infant-caregiver, what is known about how an infant's physiological system changes is inadequately understood because the timescale of measurement of both physiology and behavior may be

incommensurate. For example, most research studying psychophysiological indices of emotion regulation aggregate estimates of physiology and behaviors at time epochs of fifteen or thirty seconds, which is likely too coarse to capture key dynamic responses occurring at faster timescales.

How do infants' physiological dynamics change during bouts of social engagement with a parent at a second-to-second timescale? Here, we investigated infant physiological dynamics using a large sample of 974 infant-mother dyads and analyzed changes in respiratory sinus arrythmia (RSA) around the onset of bouts of various types of social behaviors. Using time-locked infant physiology data and micro-coded behavioral data from infant-mother matched and mismatched social engagement states, we first quantified the proportion of time infant-mother dyads spent in matched and mismatched social engagement states during the three phases of the Face-to-Face Still Face (FFSF) paradigm (see Figure 1b). We then examined the temporal dynamics of RSA by extracting empirical RSA series and randomly-chosen RSA series 10s before to 10s after the onset of bouts of specific social behaviors. We hypothesized that changes in infants' RSA would occur around the temporal proximity of bouts of social behaviors with their mothers. Specifically, given that high baseline RSA levels are associated with higher propensities for emotion and behavioral adaptivity, we expected infants' RSA levels would increase around the temporal proximity of positive social behaviors with their mothers.

Overall, we found that infants' RSA was elevated during bouts of mutual positive engagement with their mothers, but not during bouts of mutual negative engagement or mutual neutral engagement. Moreover, infants' RSA began to increase more than five seconds before the onset of bouts of mutual positive engagement and there were no such dynamic changes before or during bouts of infant positive engagement or bouts of mother positive engagement when no positive expressions from the mother or the infant occurred, respectively. Finally, increases in infants' RSA before and during bouts of mutual positive engagement were more robust and occurred more frequently for longer bouts. Our findings suggest the possibility of bi-directional associations between ongoing social interactions and infant physiological reactivity, which has important implications for typical and atypical development and can lead to new theoretical models of emotion regulation that integrate properties of physiology and behavior at closer to real-time timescales.

Abstract 3: A subset of infant vocal productions is timed to ongoing fluctuations in heart rate during play with a caregiver

While very young infants cry to regulate their autonomic state (Zeskind 1985), it is less known what other types of vocalizations regulate arousal or relate to heart rate fluctuations, a possibility that motivated the present study. Nonhuman primates time spontaneous contact calls to oscillations in heart rate, regulating their autonomic state (Borjon, et al, 2016). Like nonhuman primates and other mammals, human infant vocalizations are produced by vibrating the vocal folds, pushing air through the airways, and coordinating multiple articulatory muscles (Ghazanfar & Rendall, 2008). Inhalation and exhalation cause increases and decreases in heart rate. This process dynamically interacts with baroreceptor activity in the aortic arch producing rhythmic oscillations in heart rate and blood pressure (Julien, 2006). The present data demonstrate a subset of infant vocal productions are timed to fluctuations in heart rate. These vocalizations are more likely to induce decelerations in heart rate than non-timed vocalizations.

A total of 1,086 spontaneous vocalizations (avg(std): 87.72(40.07) emitted by 13 unique infants (5 male) between 19 and 25 months of age (22(2.66) months) were studied. Infants participated in a session of

naturalistic play with their caregiver using a variety of common toys in a playroom setting (656.08(98.15) seconds in duration). Mindware mobile monitors were placed in a backpack for the child to wear while electrocardiogram (ECG) recordings were recorded continuously at 500 Hz. ECG data were processed using the open-source software TonaFlow. The session was recorded using wall mounted cameras and vocalizations were manually coded from the audio recorded by these cameras using BORIS. All vocalizations emitted by the infant were coded with an inter-onset-interval of 300ms.

Ongoing fluctuations in instantaneous heart rate were apparent in every subject for both actual heart rate and percentile heart rate. To determine whether there was a relationship between the phase of a heart rate oscillation and vocalization onset, heart rate was converted into phase coordinates by calculating the angle of the heart rate's Hilbert transform. An angle of 0° indicates the local trough of heart rate while an angle of 180° indicates a local peak. A bootstrapped significance test revealed a significant clustering of vocalization onsets from 150° to 240°, around the local peak. Wilcoxon rank sum test revealed changes in heart rate after timed vocalizations were significantly different from non-timed vocalizations ($Z = -6.71$, $p < 0.0001$): 63.96% of vocalizations timed to a peak resulted in a deceleration while only 38.37% of non-timed vocalizations resulted in a deceleration (Figure 2a).

A subset of infant vocalizations is emitted around the local peak of heart rate and result in decelerations in heart rate, implying possible regulation of autonomic state. Manual inspection of the timed vocalizations did not reveal an obvious category of vocalization type (i.e. speech-like, incidental etc.). These vocalizations are of varying content, durations, and emitted in response to varying contexts. None were cries. Future analyses will consider vocalization type, phonetic complexity, and the posture of the infant while producing a vocalization.

Abstract 4: Measuring infants' heart rates in gaze-following situations

Because adults' gaze direction plays a critical role in the process of social learning from the early stage of development, infants' gaze following behaviour has been a core topic in developmental science. To understand the cognitive mechanism of infants' gaze following, previous studies have examined how infants' gaze following is modulated by external stimuli such as the existence of communicative cues (Senju & Csibra, 2008) and the reliability of the communicative partner (Chow, Poulin-Dubois, & Lewis, 2008). However, it remains unclear how such contextual information is integrated through internal processing and subsequently modulates infants' gaze following. A recent study showed that the modulation of gaze following behaviour by preceding eye contact is partially mediated by an elevated heart rate (Ishikawa & Itakura, 2019). In the current study, we measured infants' heart rates in the gaze following situations manipulating the existence of communicative cues and the reliability of the communicative partner. It was hypothesised that both contextual factors would (1) facilitate gaze following, and (2) the facilitation is mediated by the elevated heart rate during gaze following events.

The study involved forty-one infants aged 6 to 9 months. In the training phase, infants observed either a reliable model, consistently gazing towards a peripheral object's location, or an unreliable model, consistently looking away from the peripheral object's location. Subsequently, the infants watched a video of the same model making or not making eye contact before shifting her gaze toward one of two objects in the scene. During the task, stimuli were presented to the infants using a Tobii Spectrum Eye Tracker (Tobii pro Lab 1.118, Tobii Technology, Stockholm, Sweden), which also recorded eye movements at a sampling rate of 120 Hz. Furthermore, heart rate data were collected using a BIOPAC MP160 (Biopac System, CA, USA) and a BioNomadix (BIOPAC Systems, CA, USA).

The results indicated that both reliability and eye contact had independent effects on increasing the frequency of gaze following and resulted in elevated heart rates. These heart rate increases, in turn, predicted gaze following, irrespective of reliability or eye contact. In order to explore whether the increase in heart rate mediates between contextual factors (reliability, eye contact) and gaze following, we conducted a mediation analysis using generalized linear modelling (GLM). The outcomes of the analysis revealed that the elevated heart rate acted as a mediator between the communicative cue condition or reliability and gaze following (Figure 2b).

The findings imply that contextual factors, such as eye contact or reliability, increased the heart rate of infants and consequently facilitated their gaze following. It is important to recognize that these two contextual factors are qualitatively different: the presence of eye contact represents an immediate visual context, while the factor of reliability is knowledge acquired from prior experiences requiring memory modulation. This study indicated that even contextual factors with distinct qualitative characteristics are integrated as physiological responses within internal processing, ultimately modulating gaze following behaviour.

S.11: Forms of perinatal stress on caregiver and child outcomes

Nicole Rheinheimer [1], **Ana Okorn** [2], **Stephanie Parade** [3], **Victoria Jones** [4], **Janani Prabhakar** [1], **Marisa Spann** [5], **Sheehan Fisher** [6], **Sarah Peoples** [7], **Naomi Gancz** [8]

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Details

Abstract 1, Title: Acculturative stress and discrimination experience during pregnancy and offspring developing brain connectivity

1. Objective

Ethnic, racial, and structural inequalities, which may lead to individual experiences of acculturative stress and discrimination, are increasingly recognized as contributors to health, and these experiences may affect pregnant individuals and their developing offspring. For example, acculturative stress and discrimination can have deleterious effects on pregnant individuals' mental well-being and is associated with depression and anxiety. This study characterized acculturation and discrimination stressors during pregnancy in a sample of predominantly Hispanic adolescents and the associations of these stressors with their offspring's neonatal functional connectivity and birth outcomes.

2. Participants and Methods

A sample of 165 nulliparous predominantly Hispanic pregnant women, aged 14 to 19 years, were recruited through obstetrics and gynecology departments at two different hospitals. Participants

completed three self-report measures on acculturation and discrimination during the 2nd or 3rd trimester: 1) the Acculturation, Habits, and Interests Multicultural Scale for Adolescents (AHIMSA), 2) the Short Acculturation Scale for Hispanics (SASH), and 3) the Experiences of Discrimination Scale (EOD). They also completed measures on maternal distress. A data-driven clustering of acculturation, discrimination, perceived stress, depressive symptoms, trauma, and sociodemographic variables during pregnancy were performed to determine whether acculturation clustered with other types of factors. Birth outcomes (gestational age and Apgar scores) for offspring were obtained from medical records. Infant MRIs occurred within the first five weeks of life to assess whole-brain seed connectivity from the right and left amygdala combined into a single seed. The time course of a reference region was computed as average time course across all voxels in the region, and this was correlated with time course for every other voxel in the gray matter to create a map reflecting seed-to-whole-brain connectivity. These r-values are transformed to z-values yielding a map for each seed, representing the strength of correlation with the seed for each participant.

3. Results

Acculturation styles loaded onto separate factors from discrimination, perceived stress, depressive symptoms, trauma, and socioeconomic status. An optimal model of factors including only the AHIMSA and SASH led to the following three factors: assimilation-separation, assimilation-integration, and marginalized. Higher maternal report of assimilation-separation was associated with weaker connectivity between the amygdala and bilateral fusiform gyrus of their neonate. Infants whose mothers endorsed discrimination during pregnancy had weaker connectivity between the amygdala and prefrontal cortices (medial and anterior), and stronger connectivity between the amygdala and the left fusiform gyrus. Acculturation factors and discrimination experience during pregnancy were not associated with offspring birth outcomes after correcting for multiple comparisons.

4. Conclusion

Our findings suggest that maternal prenatal acculturative stress and discrimination may be additional stressors associated with neonatal functional connectivity of the amygdala. This is intriguing, as previous literature demonstrates an association between the fusiform and ethnic or racial processing in adults. Cautiously, results may suggest a similarity to studies with adults, noting that experience of acculturation or discrimination may have a possible effect on amygdala circuitry across generations. Further studies with a more diverse population of minoritized individuals and that use comprehensive assessment of ethnic, racial, and structural stressors are needed.

Abstract 2, Title: Maternal Preconception and Prenatal Stress Impact Children's Gut-Microbiome-Brain Axis.

Adversity exposures in the prenatal and postnatal period are associated with an increased risk of adverse health outcomes in the child after birth, including psychopathology. Even events occurring pre-conception, in a mother's own childhood, have been linked to increased health risks in offspring. Non-human animal research has provided strong evidence that the gut-microbiome and its effects on the brain through the gut-microbiome-brain axis, is a biological mechanism that could help to explain the impacts of maternal stress on offspring health. In this talk I will describe data from three studies using a sample of 450 mother-child dyads living in Singapore, that address the question of how maternal stress is associated with offspring emotional health, and how such changes in emotional health might be

supported by alterations in functioning along the gut-microbiome-brain axis. In the first study I will demonstrate how maternal childhood maltreatment (pre-conception stress) is associated with heightened internalizing symptoms in second generation children, via a pathway of worsened prenatal anxiety and depression symptoms (prenatal stress), and postnatal maternal anxiety and depression symptoms (postnatal stress). In the second study, I will present data showing how maternal pre-conception, prenatal, and postnatal stressors are each associated with changes in the microbiome of second-generation toddlers, and how those microbiome changes are in turn linked to toddler's emotional health. In a subset of that sample, I will then show how the microbiome of toddlers is associated with resting state brain activity in middle childhood, that is in turn linked to later incidence of internalizing symptoms in those same youth. Together these data will highlight the importance of multimodal measurement of maternal stress at different stages of the lifespan in establishing the impacts on a second generation of children. This research also centers the gut-microbiome-brain axis as a biological system of importance in transmitting the impacts of maternal stress to offspring, especially in ways that impact offspring emotional health.

Abstract 3, Title: How does prenatal perceived stress affect neural responses to infant cries in expectant parents?

The perinatal period is characterized by distinct neurobiological and psychological changes initiated prenatally, which may both facilitate postpartum caregiving and increase vulnerability to stress. Although parents generally report increased stress during the postpartum period, with mothers reporting higher levels of stress than fathers, less is known regarding prenatal stress and associated neurodevelopment in parents. Parents need to adapt to the high demands of caregiving, which include responding to salient infant cues, such as infant cries. Parents' neural reactivity to infant cries is especially important to understand given that infant vocalizations are the main communicative signals infants employ during the postpartum period, and infant cries vary in both their frequency and intensity to signal specific needs (e.g., hunger, discomfort, pain). Furthermore, it has been suggested that prenatal maternal stress exposure is associated with postpartum neural processing of infant cries and sensitive caregiving. Therefore, understanding the impact of perceived stress on neural responses to infant cries prenatally in expectant parents could provide clinical insight into sensitive periods associated with perinatal neurobiological reorganization and stress susceptibility, ultimately informing targeted prenatal support and early interventions for parents and their children. In the current study, we used event-related potentials to examine whether prenatal perceived stress (Perceived Stress Scale) affected neural markers of perceptual (N1, P2) and attentional (LPP) processes elicited by high- and low-distress infant cries in expectant mothers (n = 38) and fathers (n = 30) in their third trimester of pregnancy (M = 37 weeks; SD = 2 weeks). Results evidenced that there were no parental sex differences in prenatal perceived stress or neural responses to infant cries. For both mothers and fathers, prenatal perceived stress impacted parents' sustained attentional processing (LPP) of infant cries, but not early perceptual responses (N1, P2). Specifically, higher levels of prenatal perceived stress were associated with a greater LPP response to low-distress, but not high-distress, infant cries. Increased attentional processing of low-distress cries in highly stressed parents may reflect uncertainty regarding infant distress level, thereby requiring more attentional resources to interpret ambiguous infant cues. Overall, our results suggest that prenatal stress impacts processing of infant cries, even before birth. Clinical efforts aimed at alleviating prenatal stress for both mothers and fathers may mitigate the negative impact of subjective stress on the parental brain, and ultimately parent and child development.

Abstract 4, Title: Paternal mood and involvement on maternal and child outcomes.

1. Introduction

Perinatal mental health research has not been historically inclusive of father mental health and family involvement, but the relevance of fathers during the perinatal period in relation to maternal health and infant/child health is starting to be recognized. In addition, treatments for maternal perinatal mood target the mother exclusively, while fathers are an under-utilized resource to support the objectives of perinatal psychiatric treatment and maternal mental health. This presentation highlights two studies that examine the impact of paternal mood and parental involvement on maternal mood and infant/toddler health. First, a longitudinal study that explored the association of maternal and paternal postpartum depression (PPD) with toddler internalizing and externalizing behaviors while testing the mediating roles of later parental depression and interparental conflict will be presented. The second study, African American Social Support Effectiveness Treatment-Partners alleviating Perinatal Depression (ASSET-PPD), is an ongoing randomized controlled trial that focuses on prevention of postpartum depression in African American mothers by empowering fathers to support mothers' mental health and increase contributions to the family environment during the perinatal period.

2. Hypotheses

Study 1: The longitudinal study predicted that paternal depression would be uniquely associated with child behavior after controlling for maternal depression. Postpartum depression was predicted to be associated with subsequent depression, interparental conflict, and child behaviors. Study 2: The aim of the ASSET-PPD study was for the intervention to enhance fathers' support of maternal well-being and increase paternal family involvement to reduce postpartum depressive symptoms in mothers and have a positive impact on infant health.

3. Study Population & Methods

Study 1: The longitudinal study included a sample of 199 couples whose index child was an average age of 4.5 months at the postpartum assessment and 45.5 months at the toddlerhood assessment. Both members of the couple independently completed questionnaires including measures of parental depression, the interparental relationship, and child internalizing and externalizing behaviors. Study 2: The ASSET-PPD study recruited and randomized prenatal families into the treatment group or no additional treatment group. Both groups of parents complete measures of depression/anxiety, parenting behaviors, the co-parenting relationship, and infant behavior from the second trimester to 6 months postpartum. Fathers in the intervention group complete skill-based individual sessions of didactics, interactive training, and trackable objectives: four prenatal training sessions and two postpartum review sessions. Following each intervention session, fathers were asked to complete a form evaluating the instructor's performance and the topics.

4. Results

Findings from the longitudinal study suggest that both maternal and paternal PPD are associated with child internalizing and externalizing behaviors primarily through the development of later parental depression. Father depression was associated with child internalizing and externalizing behaviors after controlling for maternal depression. Preliminary results of ASSET-PPD will be presented. The two studies highlight the importance of exploring the impact fathers' mental health and family involvement on child

outcomes and family well-being and functioning. By promoting paternal mental health and involvement, we can bolster the parental team to optimize its impact on infant/child stress and development.

Abstract 5, Title: Returning to Work After Maternity Leave: Change Trajectory and Determinants of Maternal Postpartum Work Resumption Stress

An important event many mothers face is the transition back to work after maternity leave. While the experience differs among mothers, for the majority of mothers this transition represents a stressor. The stress that mothers experience in response to returning to work after maternity leave has been conceptualized as postpartum work resumption stress (PWRS). As upon the return, mothers are faced with both an initial transition and ongoing adjustment, their PWRS levels likely change throughout the transition. The first goal of the current pre-registered study is to investigate whether and how levels of PWRS change over the first six months of return in a sample of low-risk mothers of infants. While we expect levels of PWRS to change over time, we have no specific hypothesis on the nature of this change. Furthermore, following the Schlossberg's transition model, a variety of factors, including an individual's personal situation, available support, and inner strength, can determine the ability to cope with a transition. As such, the second goal of this study is to address factors, which mothers have identified themselves in previous qualitative research, that could protect them from experiencing high levels of PWRS at the moment of initial transition and over time. Specifically, we expect mothers who experience higher levels of social and work support, have higher levels of psychological capital and are better recovered from giving birth, take longer leave and experience more work flexibility, and have an infant with lower levels of negative affectivity, to have lower levels of PWRS at the start and throughout the first six months of the transition. Due to contradictory findings for the protective nature of shorter working hours, no specific hypothesis is made for this factor.
In total, 414 mothers were recruited for the study. The data collection is currently still in progress and will be completed in June 2024. Mothers are asked to complete online surveys two weeks before the return to work (T-1), at the moment of return (T0), and two weeks (T1), six weeks (T2), three months (T3) and six months (T4) after. To measure PWRS, 30-item REturn to Work INventory is used, with higher scores indicating higher levels of stress (range 1-6).
Visual inspection of the mean level change in PWRS in a sub-sample of 343 mothers suggests that PWRS levels decrease over the first six months of return (see Figure 1). Additionally, preliminary correlation analyses showed mothers who experience higher levels of social support (r=-.25), work support (r=-.49) and work flexibility (r=-.19), have higher levels of psychological capital (r=-.32), take shorter leave (r=.25), and have an infant with lower levels of negative affectivity (r=.13) to have lower levels of PWRS at the moment of return. In my presentation, results of the linear mixed effects model analysis, based on the whole sample and including the determinants of maternal PWRS, will be presented and discussed.

Abstract 6, Title: Stress-reducing Effects, Facilitators and Barriers of Time Spent Outdoors for Infants and their Mothers

Research shows that spending time outdoors reduces mental and physiological stress. For example, spending time in green environments has been shown to decrease cortisol concentrations and improve mental wellbeing in children. However, this has never been studied in infants, while infants may also benefit from stress-reducing activities, especially as their stress system is still developing. The first aim of

this study was to assess the experimental effect of outdoor pram-walking and infant carrying on stress-related behavioral and physiological measures in infants (sleep and cortisol recovery) and their mothers (mood and cortisol levels). Furthermore, children spend only 15% of their waketime outdoors, potentially due to increasing urbanicity in the past decades. The second aim of this study was therefore to identify facilitators and barriers for mothers to perform outdoor activities with their infant (e.g., outdoor walking, infant outdoor sleeping).
We performed a randomized controlled trial (RCT). After exposing the infant to a naturalistic laboratory stressor, mother-infant dyads (N=100) were randomly allocated to one of four conditions: walking in a green environment with a pram (a) or walking in a green environment with an infant carrier (b), or staying indoors with the infant in a pram (c) or staying indoors while holding/carrying the infant (d). We assessed effects of the conditions on infant sleep and salivary cortisol recovery, as well as maternal cortisol and mood. To assess facilitators and barriers of outdoor activities, we performed an online survey among mothers of 0-to-12-month-old infants (N=1275). We assessed the frequency of outdoor walking with the infants, infant carrying, and infant outdoor sleeping. We performed data-driven analyses to identify associations of these outdoor activities with demographic characteristics.
In the RCT, we found that infants slept significantly more if they were taken for a walk after the stressor, as compared to staying indoors. Preliminary analyses show a higher decrease in cortisol levels when infants were carried and held, as opposed to being in a pram, regardless of whether they were going for a walk or staying indoors. Likewise, mothers showed significantly lower cortisol levels after carrying their infant, as compared to using a pram. As for facilitators and barriers of mothers performing outdoor activities with their infants, we found that working mothers went on outdoor walks with their infants significantly less as compared to mothers on maternity leave or unemployed. Mothers were more likely to go for outdoor walks with an infant carrier when they were highly educated and if they had more than one child. Infants of mothers with lower education, as well as infants living in apartments were less likely to sleep outdoors. Other associations of sample characteristics with outdoor activities will be presented during the talk.
The current project delivers novel experimental evidence for the effects of outdoor walking and infant carrying on stress-related behavioral and physiological measures in infants and their mothers. The findings are important for perinatal healthcare, urban planning, and policies regarding maternity leave.

Abstract 7, Title: Prenatal Attachment and Infant Temperament: The Mediating Role of Postpartum Mental Health

This study examined relations between prenatal attachment, postpartum mental health, and infant temperament. It was hypothesized that prenatal attachment would be a protective factor – more bonding with the fetus would be associated with lower depression and anxiety. Less prenatal attachment/bonding and greater postnatal maternal anxiety and depression were expected to be associated with more difficult temperament profiles (i.e., greater negative affectivity).
Analyses were conducted to evaluate if postpartum depression and anxiety mediated the relationship between prenatal attachment and infant temperament factors (Positive Affect/Surgency, Negative Affectivity, Regulatory Capacity). The sample (N = 136) primarily consisted of white (86.96%), partnered (95.65%), working (88.41%) women (M Age = 32.29 years, SD = 3.85) with multiple children (60.14%). Approximately half of the infants in the sample were female (49.64%). Prenatal attachment was assessed during the third trimester of pregnancy (M = 31.12 weeks gestation, SD = 3.48). Maternal mental health and infant temperament were evaluated approximately two months postpartum (M =

9.48 weeks postpartum, SD = 1.69).
Higher prenatal attachment predicted lower postpartum anxiety (β = -0.20, p = .02); however, there was not a significant relationship between prenatal attachment and depression (β = -0.14, p = .10). Prenatal attachment (β = 0.30, p < .001) and postpartum depression (β = 0.36, p = .003) significantly predicted infant positive affect/surgency (PAS), such that mothers with greater prenatal attachment and higher depression scores reported higher PAS scores. Conversely, postpartum anxiety was negatively associated with infant PAS (β = -0.27, p = .03): higher anxiety scores were associated with lower PAS scores. Prenatal attachment also had an indirect effect on infant PAS via its effect on postpartum anxiety (β = 0.05). Postpartum anxiety predicted infant negative affectivity (NA) at a trending level (β = 0.24, p = .053). Prenatal attachment predicted infant regulatory capacity (RC) at a trending level (β = 0.15, p = .07).
Given the significant effects found in the PAS model, follow up analyses were conducted to examine the PAS subscales. Prenatal attachment significantly predicted approach (β = 0.24, p = .01), vocal reactivity (β = 0.30, p < .001), smiling and laughter (β = 0.18, p = .04), activity level (β = 0.22, p = .01), and perceptual sensitivity at a trending level (β = 0.17, p = .058). Postpartum depression significantly predicted vocal reactivity (β = 0.32, p = .01), activity level (β = 0.35, p = .005), and perceptual sensitivity (β = 0.34, p = .01). Postpartum anxiety significantly predicted vocal reactivity (β = -0.24, p = .048) and perceptual sensitivity at a trending level (β = -0.25, p = .051).
Hypotheses were partially supported, and findings suggest maternal-fetal relationships may influence postnatal mood and perceived infant temperament and should, therefore, be considered a point of intervention. Greater prenatal bonding may influence mothers' perceptions, so that positive aspects of infant temperament (e.g., smiling and laughter) are more salient. This increase in PAS may also have long term benefits, as higher levels of PAS in infancy is protective against depression/internalizing problems.

Abstract 8, Title: Maternal Childhood Maltreatment Moderates the Impact of Objective Indicators of Postpartum Stress, but Not Subjective Experiences of Parenting Stress, on Parenting Behavior and Infant Behavior Problems

Maternal stress in the postpartum period is a risk factor for parenting and infant developmental outcomes. Yet most work in this area has taken a narrow view on stress by either focusing on objectives indicators, such as life event checklists, or subjective indicators, such as self-reports of parenting stress. Little prior research has examined both objective and subjective indicators. Likewise, maternal childhood experiences are often not considered in these processes and most work in this area has focused on families of middle or high socioeconomic status. We examined both objective (postpartum life events checklist, observed infant temperamental reactivity, geocoded neighborhood risk index) and subjective (parenting stress) indicators of stress in the postpartum period in a sample of mothers who qualified for public assistance programming. We also examined maternal experiences of childhood maltreatment as a moderator of the impact of postpartum stress on parenting and infant behavior problems.

295 mothers and their infants participated in this longitudinal study. Mothers were 18 to 44 years of age and were racially and ethnically diverse (40% Hispanic; 42% White, 19% Black, 7% biracial/multiracial, 32% other races). 60% of mothers had less than or equal to a high school degree, 65% were unemployed, and all received public assistance programming (cash assistance, food stamps, or WIC).

53% of infants were female. 49% of mothers reported experiences of maltreatment in their own childhoods.

Mothers reported on their childhood experiences of maltreatment during a prenatal research assessment. At 12 months postpartum, mothers and their infants engaged in a free play task to assess parenting sensitivity and a frustration task to assess infant temperamental reactivity. Mothers also completed a stressful life events checklist and reported on their parenting stress and infant behavior problems. Home addresses at 12 months postpartum were geocoded to determine census block and a neighborhood risk index was generated for each address.

Results demonstrated that maternal childhood maltreatment moderated the impact of objective indicators of postpartum stress but not subjective experiences of postpartum stress. Observed infant temperamental reactivity and geocoded neighborhood risk were negatively associated with maternal sensitivity ($r = -.32$ and $r = -.25$ respectively, both $p < .01$), but only among mothers who experienced childhood maltreatment (interaction effects significant at $p < .05$). Likewise, stressful postpartum life events were positively associated with infant behavior problems ($r = .28$, $p = .003$), but only among mothers who experienced childhood maltreatment (interaction effect significant at $p < .001$). In contrast, maternal parenting stress was positively associated with infant behavior problems regardless of maternal childhood maltreatment history ($r = .46$, $p < .001$; interaction with maltreatment non-significant).

Results demonstrate novel mechanisms by which maternal childhood maltreatment contributes intergenerational effects and underscores the salience of postpartum stressors for parenting and infant developmental outcomes. Implications for supporting families experiencing postpartum stress, as well as methodological considerations for the measurement of stress, will be discussed.

S.12 Where do parents across cultures look for information about development and play and what information do they find?

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Summary

To fulfill their role in supporting development, parents look for information about development and play. While a lot of information is available, it is not clear what sources parents actually use, what is the content and quality of this information and how these aspects differ between cultures. We address these questions in different cultures and from different perspectives. The first study compares parental reports from 3 countries about frequency of use of information sources about motor development. The second and third study describe content analyses of information sources about infant play activities and milestones in 2 countries. The final study compares information provided by governmental or professional organizations in 5 countries and internationally regarding infant development and play. The studies provide insights from multiple sites and from both parents and information sources and highlight ways that parents' knowledge and practices may be shaped in different cultures.

Details

Abstract 1, Where do parents turn for information about motor development in the US, Israel and the Netherlands?:

At a time when large amounts of information are readily available to parents regarding their baby's development, it is important to gain a better understanding of what sources parents actually turn to. Cultural models differ in the importance attributed to family members, experts and parents' own competence (e.g., Harkness et al., 2007), it is likely that cultural differences exist in the type of sources parents turn to. Parental knowledge may affect the way parents interact with their children and hence child development (Orlando et al., 2023) and therefore, differences in this knowledge might ultimately explain differences in development. Still, it is not yet well known what information sources about early development parents utilize most and if these sources differ between cultures. Therefore, we studied what type of sources are used by parents for obtaining information about one developmental domain, namely, motor development, in three presumably "western" countries: the United States (US), Israel (IL) and the Netherlands (NL). We first tested separately per culture how the frequency of use of the different sources varied. Following this, we tested how the use of the different sources varied across the three cultures.

Participants were 255 US, 206 IL and 198 NL middle-class parents of first-born children aged 1-8 months (M=4.21, SD=1.77; 53% female). As part of a larger survey, parents indicated on a 5-point Likert scale (ranging from never to always) how often they use different information sources. The resulting scales indicate the frequency of use of: external sources (e.g., books, websites), personal network (e.g., friends, family), experts (e.g. pediatrician) and their own observations.

First, a series of Friedman tests, performed separately per cultural group, showed that the use of sources significantly varied (all *p* values below .001). A series of bivariate comparisons using Wilcoxon signed-rank test with the Bonferroni correction revealed that in the US, parents used significantly more expert sources followed by external or personal sources. IL parents reported using most personal sources followed by experts and In NL the personal network was consulted less than all other sources. Next, a comparison across cultures using a MANOVA and controlling for parental education, showed a main effect of culture ($F(8,1288)=37.90$, $p<.001$, $\phi^2_p=.19$). Pairwise comparisons using Bonferroni correction (figure 1) reveal that NL parents use own observations significantly more than IL parents. US parents turn to experts more than both IL and NL parents. IL parents use their personal network more than US parents who use these sources more than NL parents. Finally, both NL and US parents use external sources more than IL parents.

Thus, results show that the emphasis on types of sources differs between cultures. These differences might reflect different cultural models where a different weight is assigned to the opinions of personal network or experts. Next to shedding light on how culture might affect parental knowledge and therefore practices and development, results also indicate the importance of accounting for cultural context when designing interventions for increasing parental knowledge.

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Abstract 2, **What information are parents in Brazil likely to find when they seek education in websites about play and development for children under 1-year-old?:** Play is a low-cost activity accessible to various families. Parents often serve as the primary play partners for children in the early years of life and significantly impact their development (Damast et al., 1996; Dinker & Snyder, 2020). Parents

commonly seek information about child development and play on the internet and other media platforms (Harvey et al., 2017; Orlando et al., 2023; Scarzello et al., 2016). However, it is unclear what information is shared with parents on popular websites and what is the quality of this information. This research aimed to analyze the content of information on play activities and milestones available on websites in Brazil to infants' parents.
We hypothesized that the content would have a variety of information about play activities and milestones but that most play activities suggested would be low in quality.
Study population: Play and Development Searches in Google identified 166 sources for content analysis by trained researchers using a standardized coding scheme. Sources included websites available online and created by professional organizations, commercial entities, individuals, and government organizations/agencies.
Methods: Source content was extracted and coded by two independent coders with >87% inter-coder agreement. For each source, information was extracted about: authors (i.e., qualifications, credentials, education/experience); specific information about each play activity (i.e., age, social and language opportunities, toys recommendation, infant's position and location) and milestones (i.e., age and domain); quality of each play activity was rated by determining whether it encouraged or not for child-initiated movement and whether it promoted opportunity of manual interaction with objects.
Results: We identified 610 play activities across 100 sources and 33 main categories of milestones across 66 sources. Websites provided few to no general information (e.g., author qualifications). Most play activities and milestones provided information for the age range, including initial and/or final age for each milestone. The majority of play activities mentioned the presence of a caregiver during the activity (70.5%) and the presence of toys within the baby's view (70.5%). Less than half of play activities included information on the infant's position (41.6%) and location (44.7%). Moreover, few play activities explicitly encouraged motor opportunities (23.1%) and problem-solving with objects (10.0%), and most play activities were considered of low quality (66.3%). Most milestones were within the motor domain (56%), followed by the cognitive (19.7%) and language/social domains (13.9%).
Conclusions: The findings revealed a lack of detailed information regarding the description of websites and their play activities and developmental milestones. The available internet information on play activities might lead parents to improperly carry them out, hindering children under one year old from realizing the full developmental potential of play activities. Considering this, we conclude that the information available on the internet about play activities and developmental milestones needs improvement. It is essential for the content to be written in an accessible manner by experts in child development, ensuring that it is understandable and provides greater details in its description. This way, parents accessing these websites can comprehend and follow the instructions appropriately.

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Abstract 3, What information are parents in the US likely to find when they seek education about infant play, milestones, and development?: Parents commonly look to popular sources (i.e., websites, applications, books) for information about infant development and play. Research has shown that high-quality parent education about infant development and how to interact or play with infants can positively impact both parent outcomes and child development. However, it is unclear what information is shared with parents in popular sources and what is the quality of this information. The purpose of this research was to systematically analyze the content available to educate parents about infant development and play.
Hypotheses: We hypothesized that the content would have a strong emphasis on developmental products (i.e., milestones) and that the majority of practices and play activities suggested would be low

in quality.
Study population: Play, Milestone, and Development Searches in Google identified 313 sources for content analysis by trained researchers using a standardized coding scheme. Sources included websites, books, apps, and social media platforms created by professional organizations, commercial entities, individuals, the popular press, and government organizations/agencies.
Methods: Source content was extracted and coded by two independent coders with >90% inter-coder agreement. For each source, information was extracted about the authors (i.e., qualifications, credentials, education/experience), developmental process, parents' role in development, and determining infant readiness to play. Further, information about each milestone, play activity or practice, and toy recommendation in the source was extracted. Quality of each play activity or practice was rated based on whether it encouraged, provided the potential for, or did not allow for child-initiated movement to promote motor development, manual interaction with objects to promote cognition, and responsive communication to promote language development.
Results: Although not consistently provided, most sources provided author information (67.7% of the sources shared author credentials; 71.9% shared qualifications), nor was information about the developmental process (37.7%), parents' role in development (46.7%), or determining an infant's readiness to play (22.1%). Milestones comprised a majority of the content overall (n=11,083), outnumbering play activities and practices (n=4370) 2.5 to one and toy recommendations (n=3671) three to one. Search terminology impacts the information parents receive with the Milestone and Development searches emphasizing a passive approach of observing developmental milestones rather than suggesting activities to actively facilitate learning and milestone development. There were a large number of play activities and practices (n=4370) identified, however, only 44.2% were high-quality in the motor domain, 24.2% were high-quality in the language domain, and 17.8% were high quality in the cognitive domain.
Conclusions and implications: These findings highlight the need for early educators and clinicians to discuss parents' online information-gathering process and findings. They also highlight the need for innovative universal parent-education programs that focus on activities to facilitate early development. This type of education has potential to benefit all families, with particular benefits for families with children who have unidentified or untreated developmental delays. The strong focus on developmental products in the current parent education content does not reflect the more recent focus on process in developmental science and does not empower parents to support their children's development.

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Abstract 4, Comparison of Formal Parent Education Content about Infant Development in Sources from Five Countries and Internationally: Parental knowledge about infant development is significant for forming developmental expectations and awareness of infant's needs and behaviors. Parental knowledge is shaped by information from formal and informal sources, social interaction, socio-cultural beliefs, and personal experiences (McCatharn, et al.,2021; Orlando et al., 2023). Parental values and norms about development differ among cultures, alongside cultural differences in infant motor development (Adolph et al., 2010; Oudgenoeg-Paz, et al.,2020). These differences might, at least partially, be shaped by the education provided to parents. Therefore, it is important to investigate cross-cultural differences in the educational materials available to parents. We aimed to compare the information shared with parents about infant development provided by formal sources [e.g., governmental, medical organizations] in five countries [the United States of America (US), Brazil (BR), the Netherlands (NL), Israel (IL) and Saudi Arabia (SA)] and from international organizations (i.e., WHO, UNICEF).

Method: Site-native trained researchers identified the relevant sources. Content was coded and analyzed according to a defined scheme, to identify general topic areas and specific content codes about developmental milestones, red-flags, activities to avoid, and recommended activities.
Results: Fourteen sources were analyzed with 1-5 sources per site. Average inter-coder agreement was 91.9% (SD= 3.8). In total, there were 183 milestone, 59 red-flag, 12 activities to avoid, and 108 recommended activity codes distributed among 36 different general topics. The emphasis was on developmental milestones which represented at least one third of the codes per site. Within the milestones, the main domains were motor with 96 codes (78 gross, 18 fine), language with 46 (29 expressive, 17 receptive), cognitive with 35, and social-emotional with 29 codes. Regarding activities to avoid, most codes related to avoiding objects in the environment, such as screens or containers. Regions shared information about the same general topics; most topics (69.4%) had at least one code mentioned by source(s) from five or six of the regions. Moreover, the specific codes shared within topic areas varied among the regions; most codes (54.2%) were mentioned by source(s) from only one or two of the regions. The US sources mentioned 87.9% of the 183 milestones, a greater percentage than the other regions ($\chi 2$ (25)=1130.000, p<.001, ϕc =.913;). The IL materials mentioned the greatest percentage (57.6%) of the red-flag codes ($\chi 2$ (25)=965.000, p<.001 , ϕc =.913). IL (80.0%) and the US (69.1%) mentioned a majority of the recommended activity codes (X2(16)=1096.000, p<.001, ϕc =.894).
Conclusions: The findings highlight the shared information across the content classifications coded. It was possible to identify region-specific accentuate and nuances that were emphasized in the way the information is presented, in the content as well as its level of detail. The specific information of each site may be related to environmental socio-cultural variables as well as reflecting the local mother-infant care and health-system. Such analyses, combined with knowledge about infant development, might shed light on the way such educational sources contribute to infant development. Future studies could also consider a joint endeavor to establish uniformity in official information sources while adding culturally diverse information.

S.13 Shaping cognition in joint action: Multilevel micro-processes organise infant attention

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Summary

How do infants coordinate attention to learn in shared interactions? Traditional approaches have shown that infants are responsive to ostensive communication. To understand interpersonal cognition, however, we need to examine the dynamic mechanisms that determine how infants pay attention in real-world settings. This international symposium brings together cutting-edge and diverse methods to assess the sub-second processes that organise infant attention, across different naturalistic contexts, in typical and atypical development. Papers 1 and 2 use eye-tracking to examine infant sensitivity to salient action-generated contingencies, whilst Paper 3 records fluctuations in infants' endogenous neural activity. Testing micro-processes at home, Paper 4 reports dual eye-tracking with infants at increased likelihood of autism. All four papers suggest infants track salient sensorimotor contingencies, with implications for developing mechanistic frameworks of atypical inter-dyadic learning.

Details

Abstract 1, Generalizability and flexibility of the multiple pathways to joint attention:

Joint attention, the ability to socially coordinate visual attention to an object, plays a pivotal role in healthy developmental outcomes. Previous work (Yu & Smith, 2017) found that parents and infants achieve joint attention through multiple pathways (e.g., gaze following, hand following). However, previous evidence is from a lab-based paradigm wherein parents and infants played with three toys in a stripped-down lab environment. Here, we test the generalizability and the flexibility of the sensory-motor pathways that lead to joint attention.
Study 1 investigated the generalizability of joint attention pathways with a naturalistic play session. Parents and infants (12-26 months) engaged in play with 10 toys in a living-room like lab setting. Head-mounted eye-trackers enabled precise recording of parents' and infants' visual attention (Figure 1A). The moments when both participants looked at the same object (Figure 1B) were classified as joint attention (JA). Each JA instance was categorized as either infant-led or parent-led based on who initiated JA (Figure 1C), and was also classified based on the pathway used for initiation (following gaze or following leader's or follower's hands). Joint attention was frequent during the play session, with dyads entering JA M = 5.73 times per minute. For infant-led bouts, parents were equally likely to join in via gaze following and following the infant's hand ($t(97) = 1.77$, $p = .08$), whereas following their own hand was less common. For parent-led attention bouts, infants most often joined in by following their parent's hand ($ts > 2.75$, $ps < .007$), although they also frequently followed their own hand. Infants rarely joined in by following their parents' gaze. Thus, the present study in a naturalistic setting replicated the two major findings from the previous study in a lab setting: 1) both infant-led and parent-led JA bouts are achieved through multiple pathways; and 2) parents rely more on gaze following while infants rely more on hand following.
Study 2 tested the flexibility of joint attention pathways within a novel context—the everyday activity of making peanut butter and jelly sandwiches. Infants (12-25 months) were seated in a high chair and observed their parents making sandwiches. All other methods were consistent with Study 1. We found that parents and their infants can still establish JA in this context as often as they do during toy play (M = 6.04 bouts per minute). However, due to the paucity of manual actions from infant observers in this activity compared with toy play, we found that both parents and children almost exclusively initiated joint attention by following the parent's hands ($Fs > 126.1$, $ps < .001$).
In conclusion, our findings underscore the flexibility and generalizability of a multi-pathway solution to joint attention across diverse parent-child interaction settings. Such an adaptive system allows for fluid and coordinated joint attention across a variety of situations, as dyads can shift to a different pathway when others are not available.

Abstract 2, The Development of Early Sensitivity to Visual Saliency during Parent-Infant Object Play:

Young infants show dominant sensitivities to visual saliency in their surroundings, such as an object's distinguished color, luminance, and associated motion contrast (Frank et al., 2009; Kwon et al., 2016). With the rapidly developing attention skills, parents' referential input plays a key role in organizing infants' visual input during free-viewing (Suarez-Rivera et al., 2019; Yu & Smith, 2016). However, we know relatively little about how visual selection develops socially through naturally occurring visual experiences. The present study investigates how parental scaffolding – verbal and/or visual cues – influences developmental changes in sensitivity to visual saliency as a function of age in the context of interactive object play.

The present study observed a 5-minute-20-second object play with a sample of 30 parent-infant dyads, including 10 infants aged 6, 12, and 18 months. During object play, the parent was asked to play with the infant with a set of toys. A head-mounted eye tracker was used to record infants' scenes and corresponding gaze behaviors. Trained coders annotated target behaviors, such as (1) infant's gaze allocation to objects (Figure 1D) and (2) parental referential cues: nonverbal cues (parents' hand actions on objects), verbal cues (parents' verbal phrases), and multimodal cues (parents labeled the handled object simultaneously). To quantify the saliency values, videos of infants' scenery recordings were also fed into a saliency program that employed Itti's saliency algorithm (Itti et al., 1998; Figure 1E).

The preliminary analyses first demonstrated the effect of reference types on infant object looking: all the infants from three age groups attended to objects more when parents used multimodal cues, following nonverbal cues and verbal cues by the least ($\chi^2 = 1440.97$, $p < .001$). Second, the hierarchical generalized model on the duration of object-directed attention found a three-way interaction amongst saliency levels, reference types, and infant's age groups, suggesting that infants exhibited various sensitivities to the saliency change according to the referential type ($\chi^2 = 695.34$, $p < .001$; see Figure 1F). For example, when parents used multimodal or nonverbal cues alone, both 6- and 12-month-olds experienced more object-directed attention with increasing saliency change in the scenes, but 18-month-olds did not; 6-month-olds exhibited more object-directed attention when the standardized saliency value was above the average ($z = 3.87$, $p < .001$). Lastly, 18-month-olds were overall less sensitive to saliency change in their scenes and had more object-directed attention following verbal cues in contrast with 6-month-olds ($z = 3.25$, $p = .003$) or 12-month-olds ($z = 2.71$, $p = .018$).

The present study revealed the developmental sensitivities of visual saliency and the potential mechanism underlying the role of parental referential scaffolding in organizing infants' attention in a social context. In the discussion, we will speculate the nature of the additive effect of auditory input on visual saliency – how parental auditory input can impact infants' corresponding visual experiences and discuss the further implications for the developmental changes from exogenous to endogenous attention processes in learning and communication.

Abstract 3, Endogenous oscillatory rhythms and interactive contingencies jointly influence infant attention during early infant-caregiver interaction:

Introduction. How do inter-individual processes drive the allocation of infant attention in shared interactions? Whilst adult-led attentional structuring perspectives suggest caregivers didactically organise their infant's attention, other accounts emphasise bidirectional influences: that caregivers follow and respond to modulations in infant behaviour.

Recording infant EEG during table-top play with their caregiver, we examine the (inter)-dependent influences of infants' endogenous cognitive processing, and inter-dyadic micro-behavioural contingencies in structuring infant attention. To do so, we assess forwards-predictive and reactive changes in infant neural activity and caregiver behaviour, relative to infant attention.

Method. Thirty-two-channel EEG was recorded from infants and caregivers whilst they engaged in table-top-play with 3 toys. Gaze and vocal behaviours were coded offline and synchronised with the EEG signal. Sixty-six dyads contributed data (M=11.18 months, SD=1.27).

Infant theta activity (3-6Hz; a marker of endogenously driven attention) was extracted over fronto-central electrodes via continuous Morlet wavelet convolution. Taking the absolute derivative of the signal, rate of change in the fundamental frequency (F0) of the caregiver's voice (indexing vocal saliency) was also computed. All variables were re-sampled to 50Hz.

To examine whether infants' neural activity forwards-predicted infant look durations, a cross-correlation was conducted at time-lags -30 to +30s. To assess reactive changes in infant theta following object-directed attention, we employed three analyses. First, linear-mixed effects models examined associations between the length of infant object attention and average theta. Second, event-locking theta to attention onsets, we assessed immediate modulations in neural activity in the 5s after look onset. Finally, averaging theta in three chunks, we tested whether infants' endogenous processing increased over attention episodes.

The same analyses were repeated with caregiver look durations and vocal saliency as the comparison variables.

Results. Findings indicated that both fluctuations in infant's neural activity and modulations in adult behaviours increased, reactively, in the time after infant attention onsets.

Rather than endogenous processing driving infant attentiveness, cross-correlation analyses indicated infant attention largely forwards-predicted fluctuations in theta activity, with cluster-based permutation identifying significant time-lags from -2 to +6 seconds ($p=0.004$; Figure 2A). Consistent with this, linear mixed effects showed a significant association between infant attention durations and average theta ($p<0.001$). Event-locked analyses revealed little modulation in theta over attention episodes ($ps>0.05$; Figure 2B).

Against adult-led perspectives, cross-correlations revealed neither caregiver gaze, nor vocal saliency forwards-predicted infant attention ($ps>0.05$). Caregivers were, instead, reactive to re-orientations in infant behaviour. Event-locked analyses showed caregivers rapidly modulated their gaze in response to shifts in infant attention, with a significant decrease in caregiver attention durations after the onset of infant attention ($p=0.009$; Figure 2C). Over longer looks, however, caregiver attention durations significantly increased ($ps<0.05$). Linear mixed effects also revealed longer object-directed attention co-occurred with greater rate-of-change in caregiver F0 ($p< 0.001$; Figure 2D); which fluctuated over the duration of the look ($ps<0.05$).

Discussion. Findings suggest infant attention is asymmetric, related to their endogenous cognitive processing and to consistent, reactive contingency of the caregiver. Data-driven approaches, utilising neural and behavioural data, will be crucial to understanding the processes that support language acquisition.

Abstract 4, Infant-Caregiver Coordinated Visual Attention in Early Infancy: An Investigation Using Home-based Head-mounted Eye Tracking:

Background: Coordinated visual attention (CVA), the ability to coordinate attention with a social partner, is critical for the development of social communication and language(1). Head-mounted eye tracking (HMET) is an effective tool for recording moment-to-moment changes in looking behavior embedded in free-flowing social interactions from the first-person perspective(2). HMET studies in 9- to 48-month-

olds revealed that CVA bouts towards toys (or "joint attention") emerged through head-eye coordination between infants and caregivers(3). Additionally, the pattern of multimodal coordination leading to joint attention differed in children with autism spectrum disorder (ASD) compared to typically developing children(4). The present study extended existing HMET research by examining CVA in younger infants with low (LL) and elevated likelihood (EL) for ASD at 8 months, an age before the onset of clinical-level social communication impairments and language delays. Additionally, we carried out HMET data collection at homes, a critical context for infant-caregiver interactions and infant learning.
Methods: Participants of the ongoing study were 40 infant-caregiver dyads (18 female infants; NEL=25). The current analyses included 8 infant-caregiver dyads assessed at 8 months (3 female infants; NEL=6). During home visits, the dyads were seated on the floor with a standard set of toys. Caregivers were instructed to play with their infants as they normally would for 10 minutes. We examined looking behavior towards three areas of interests (AOIs): partner's face, partner's body, and toys. CVA was defined as the dyad looking at the same AOI for more than 500ms (with a gap of no longer than 200ms). We identified two types of CVA: joint attention towards toys and mutual face looking. Caregivers also reported on infants' social communication skills.
Results: Infants and their caregivers displayed differential looking patterns towards the AOIs (Figure 2E). Infants spent a greater proportion of time looking at the toys than the partner's face and body, confirming our published findings obtained from the full sample. In contrast, the caregivers spent more time looking at their partners and less time looking at the toys compared to the infants. The dyads displayed more bouts of joint attention to toys (M=57.38 bouts, SD=31.15) than mutual face looking (M=16.00 bouts, SD=10.62) during the play session. They spent a greater proportion of time engaged in joint attention (M=8.87%, SD=2.59) than mutual face looking (M=0.68, SD=1.14). However, CVA bouts are, on average, relatively brief across both types (MToy=1.14s, SD=0.30; MFace=0.86s, SD=0.16). Tentatively, the amount of mutual face looking was positively associated with infants' speech ability (r=.57).
Conclusion: Our findings suggest that infants and their caregivers engaged in different looking patterns during triadic (infant-toy-caregiver) interactions, consistent with existing HMET findings. It is likely that caregivers were frequently referencing their infants and attempting to follow their lead. CVA bouts are frequent, yet brief in more naturalistic environments where there were more environmental stimuli (e.g., toys) compared to controlled laboratory settings. Future analyses will include data from 32 additional dyads that are currently being processed. We will examine group differences (EL versus LL) in CVA and the association between CVA and social communication.

S.14 Understanding the impact of maternal and paternal perinatal experiences on caregiving dynamics and infant regulation

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Details

Abstract 1, Exploring trajectories of parental bonding: On the role of family predictors and perinatal distress:

Parental bonding towards the child holds substantial importance in child development and the well-being of both parents and children. Therefore, it is crucial to gain insights into the diverse trajectories of bonding difficulties during the postpartum period. Furthermore, the perinatal period is commonly recognized as a potentially challenging time during which parents may face a range of mental health difficulties and perinatal distress. Yet, there is a scarcity of research examining the longitudinal trajectories of parental bonding in the postpartum period, leaving questions regarding the impact of certain aspects of the peripartum period on these trajectories, such as parental mental well-being, unanswered. Consequently, this study explored the trajectories of both maternal and paternal bonding with the inclusion of various potential predictor variables of trajectory class membership in a large community-based sample. As part of this exploration, we chose to incorporate various prenatal parental mental health factors, as well as the subjective birth experience, difficult child temperament, family characteristics, and sociodemographic characteristics as predictor variables. We anticipated to identify distinct groups of mothers and fathers with varying trajectories of bonding, which will be influenced by the extent of bonding difficulties the parents face. We also hypothesized that certain predictor variables will have a differential impact on which trajectory class the mothers and fathers will be assigned to, respectively.

This study utilized data from the longitudinal cohort study DREAM to investigate the trajectories of maternal (n = 1,761) and paternal (n = 1,128) bonding at eight weeks, 14 months, and two years postpartum. Parental bonding difficulties were assessed using the Postpartum Bonding Questionnaire. To identify distinct trajectories of bonding difficulties, we employed Growth Mixture Modelling to determine the best-fitting models separately for mothers and fathers. Additionally, several potential predictors of trajectory class membership were examined through multinomial logistic regression.

Three distinct trajectory classes of bonding difficulties were identified in both maternal and paternal samples: “low-steady”, “recovering”, and “aggravating”. Parents in the “recovering” and “aggravating” classes not only encountered clinically significant bonding difficulties at some point during the study period, but also experienced fluctuating bonding difficulties over time. Multinomial logistic regression analysis also revealed various predictors of trajectory class membership. For mothers, significant predictors included depressive symptoms, obsessive-compulsive symptoms, anger/hostility symptoms, subjective birth experience, and difficult child temperament. For fathers, predictors included subjective birth experience, difficult child temperament, first-time parent, and age.

This study challenges the traditional assumption of bonding as a stable phenomenon through the identification of non-steady trajectories, acknowledging that clinical bonding difficulties tend to manifest in variable courses over time. Our findings on predictors of trajectory class membership underscore the pivotal role of parental mental health and peripartum stressors in shaping parental bonding experiences. Recognizing the diverse trajectories of bonding difficulties and their predictors offers valuable insights for the development of more effective interventions and support systems to promote healthy parent-child bonding.

Abstract 2, Title: Pre-to-Postnatal Coparenting Discrepancies and Infant Behavior Problems: The Mediational Role of Parental Distress

Abstract 2, Text:

Coparenting is a central index of family functioning (Van Egeren, 2004). Although coparenting is almost always assessed in reference to an actual child, parents can form coparenting expectations prenatally. Very few studies, however, have examined whether the degree to which prenatal coparenting expectations are met is predictive of infant development. Expectancy Violation Theory (EVT) (Floyd & Voloudakis, 1999) holds that negative violations of expectancies can lead to disappointment and in turn to postnatal problems in mental health domains (Flykt et al., 2012). The present study examined pre-to-postnatal discrepancies in coparenting and their link with infant behavior problems at 12 months. From EVT, it was hypothesized that any linkages obtained would be mediated by levels of maternal distress.

Data were drawn from a larger NIH-funded study of 210 first-child (55% girls) families. Families were predominantly White (80%), fairly well-educated, with a median yearly family income of $90,000. Families were home-visited in the 3rd trimester of pregnancy and again at 1, 3, 6, and 12 months post-partum. Coparenting at each occasion was assessed with the Coparenting Relationship Scale (CRS) (Feinberg et al., 2012), with items slightly re-worded during the prenatal assessment to inquire about mothers' expectations about coparenting. Five of the 7 CRS subscales (agreement, support, endorsement, closeness, and division of labor) were composited into a positive coparenting score, with the remaining 2 (conflict and undermining) composited into a negative coparenting score. Positive coparenting discrepancy scores were calculated by subtracting each postnatal positive coparenting score from the prenatal positive expectation score. The higher the positive coparenting discrepancy score, the greater the degree to which prenatal positive coparenting expectations were (unhappily) not met. Negative coparenting discrepancy scores were similarly calculated, with higher scores indicating that negative prenatal coparenting expectations were (happily) not met. Infant behavior problems at 12 months were assessed with the Infant and Toddler Social Emotional Assessment (ITSEA) (Carter et al., 2003). Lastly, at each age point mothers completed the Beck Depression Inventory (Beck et al.,1966), the Beck Anxiety Inventory (Beck et al., 1988), and the anger-hostility subscale (6 items) from the SCL-90-R (Derogatis, 1992). Depressive, anxiety, and hostility scales were composited into a maternal distress scale at each age point.

Correlational and regression analyses revealed that coparenting discrepancy scores were associated, in expected directions, with maternal distress (ps < .05) at each postnatal age point. Maternal distress at each age point, in turn, was associated in expected directions with ITSEA externalizing, internalizing, and dysregulation infant behavior problem dimensions (ps < .05). Mediational analyses, using the Hayes PROCESS macro (Hayes, 2018), revealed that mothers' distress at 12 months mediated the link between mothers prenatal-to-12 month positive and negative coparenting discrepancy scores and ITSEA infant behavior problems in externalizing, internalizing, and dysregulation domains. Figures 1 and 2 depict mediational paths for infant externalizing behavior. This study demonstrated that pre-to-postnatal coparenting discrepancies can place infants at risk for elevated behavior problems via their effects on maternal distress, supporting predictions from Expectancy Violation Theory. Discussion will focus on implications of these findings for intervention.

Abstract 3, Title: Prenatal Adult Attachment, Parent Emotions to Infant Crying, and Infant Reactivity: Mediational Role of Prenatal Relationship Satisfaction and Moderation by Fathers' Prenatal Alcohol Use

Abstract 3, Text:

Adult attachment is an important predictor of romantic relationship quality or satisfaction. Meta-analytic reviews indicate that dimensions of insecure adult attachments such as anxiety (ANX) and avoidance (AV) may play a critical role in all aspects of couple relationship quality (Li & Chan, 2012). A small body of literature indicates that poor prenatal romantic relationship quality has a negative impact on parenting and infant reactivity and may mediate associations between insecure adult attachment and parent-infant outcomes (Tanner Stapleton et al., 2012), but most studies are limited to mothers. In addition, fathers' alcohol use may exacerbate associations between insecure adult attachment/prenatal relationship quality and parent-infant outcomes, but few studies have examined the role of fathers' prenatal alcohol use in this context. We hypothesized that parents' insecure adult attachments (ANX and AV) measured prenatally would be associated with lower prenatal relationship quality, which in turn would be predictive of parents' frustration and anxiety with infant crying and higher infant reactivity. The role of fathers' prenatal alcohol use was also explored as a moderator of these associations.

Couples included heavy drinking fathers and low drinking or abstaining mothers expecting their first child together (n = 161; infants: 71% White, 51% female). Both partners completed measures of current alcohol use (Timeline Followback, Sobell & Sobell, 1992), adult attachment questionnaire (Fraley et al., 2000), and relationship satisfaction (Kurdek, 1992) in the second to third trimester; anxiety and frustration subscales of a measure of parent emotional reactions toward infant crying (Leerkes & Qu, 2020), and infant reactivity (Gartstein & Rothbart, 2003) at 6-months of infant age.

Results from path analyses conducted separately for fathers and mothers are displayed in Figure 1. Both models fit the data well, father model: $\chi 2$ (6, N = 157) = 10.45, p = .11, RMSEA = .07, CFI = .97; mother model: $\chi 2$ (6, N = 161) = 8.80, p = .18, RMSEA = .05, CFI = .95. For fathers, higher ANX and AV were both associated with lower prenatal relationship satisfaction. Lower relationship satisfaction was associated with high paternal anxiety and frustration toward infant and high paternal perceptions of infant reactivity. For mothers, high ANX and AV were associated with low relationship satisfaction, which in turn was predictive of higher frustration with infant and higher maternal perceptions of infant reactivity. Prenatal relationship satisfaction was not predictive of postnatal anxiety to infant crying. There was a significant interaction effect of fathers' alcohol use (number of drinking days prenatally) and fathers' prenatal ANX on fathers' postnatal frustration with infant crying. Simple slopes indicated that the association between fathers' ANX and frustration was significant at average and high levels of alcohol use, but not at low levels of alcohol use. Fathers' alcohol use did not moderate associations between maternal prenatal variables and postnatal outcomes. Results highlight the central role of prenatal relationship satisfaction and that for fathers, alcohol use may exacerbate associations between insecure adult attachment and parenting emotions. Implications for parenting and infant development will be discussed.

Abstract 4, Assessing maternal distress in a Czech sample: Validation of the Baby Preparation and Worry Scale (Baby-PAWS):

Assessing maternal mental health, particularly distress during pregnancy, is important given the association with adverse impacts to both maternal and offspring psychological and physical health. Existing pregnancy-specific questionnaires assess various concerns expectant mothers may experience, including worries about child health outcomes, maternal appearance changes, the process of labor, etc. However, existing measures fail to examine anticipatory worries experienced during pregnancy about postnatal practical considerations (e.g., worries about childcare, social support, relationship with the partner, caregiving abilities, etc.). Thus, the Baby Preparation and Worry Scale (Baby-PAWS, Erickson et

al., 2020) was developed with a U.S. sample. The present study examined the cross-cultural applicability of the Baby-PAWS in a Czech sample, specifically Baby-PAWS structure and associations with maternal depression, general and pregnancy-specific anxiety measures.

Healthy pregnant women (*N* = 104) completed the following questionnaires during their third trimester: (1) Baby Preparation and Worry Scale (Baby-PAWS; Erickson et al., 2020); (2) Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987); (3) State subscale of the State Trait Anxiety Inventory (STAI; Spielberger, 1985); and (4) Pregnancy Related Anxieties Questionnaire–Revised (PRAQ-R; Huizink et al., 2004). Exploratory Factor Analysis (EFA) was performed using Principal Component Analysis, with results guiding computation of scale/subscale scores. Cronbach's alphas were computed to assess internal consistency for Baby PAWS total and subscale scores. Bivariate correlations were computed between Baby-PAWS scores, prenatal anxiety and depression indicators, marking concurrent validity.

The EFA yielded a four-factor structure for the Baby-PAWS in the Czech sample, whereas U.S. data showed a three-factor structure (Factor 1 α = .811; Factor 2 α = .807; Factor 3 α = .817; and Factor 4 α = .613). Many Baby-PAWS items clustered similarly to the U.S validation study. However, notable differences in component items resulted in modifications to two of the existing U.S. factor labels, in addition to introduction of the fourth factor. Moderate significant associations were observed between the overall Baby-PAWS scale as well as factors and maternal anxiety (i.e., overall PRAQ-R scale and subscales; STAI; see Table 1). There were no significant associations between the Baby-PAWS total score/subscales and maternal depression (i.e., EPDS; Table 1).

This investigation demonstrates satisfactory internal consistency and concurrent validity of the Czech version of the Baby-PAWS questionnaire, supporting the clinical and research utility of this instrument with individuals outside of the U.S. The focus on "anticipatory worries" more directly captures experiences associated with anxiety, although associations with depression were observed for US and Dutch samples (Erickson et al., 2020; Bruinhof et al., 2023). Mixed results for associations with established anxiety versus depressive measures highlight the importance of continued cross-cultural research into maternal/perinatal mental health, contributing to our improved understanding of distinct experiences of these symptom sets.

Abstract 5, Maternal perinatal stress and playful behavior:

There is strong evidence indicating that parenting stress exerts a disruptive influence on early interactions (e.g., Hulth-Bocks & Hughes, 2008). Play is an essential part of mother-child interactions and is particularly sensitive to contextual factors such as that it usually decreases if circumstances are not optimal (Pellegrini & Smith, 2006). In fact, there is evidence suggesting that stress is negatively associated with playful behavior of mothers with their preschool-age children (e.g., Zhang et al., 2016). However, children and caregivers co-construct social game routines, such as peek-a-boo, already in infancy (Fantasia et al., 2014). Consequently, the aim of this study was to investigate the relationship between maternal perceived perinatal stress and her playful behavior with their children in the second year of life.

Overall, 71 mother-child dyads were included in the study. Mothers (M_{age} = 32 years, 59% primiparous, urban sample, middle-to-high SES) completed the Perceived Stress Scale twice during the first, second and third trimester of pregnancy, as well as during the first 8 weeks postpartum. When children were 15 months (*M* = 15.4 months, *SD* = .27), we observed mother-child dyads during a game of peek-a-boo,

Back to top

where mothers were instructed to play the game with as many repetition as they wished and thought their infant enjoyed it. We coded the duration of the play session and the number of game repetitions. Following Nomikou et al. (2017), we also measured the frequency and duration of basic (i.e., covering, uncovering, acknowledgment) and optional game phases (i.e., preparation, waiting) as well as game-unrelated behavior (e.g., tickling).

On average, mother-child dyads played 11 rounds of peek-a-boo (*SD* = 4.5, *range* = 3 – 24) within an average 98s long play interaction (*SD* = 47s, *range* = 24s – 325s). Dyads spent the majority of play time (*M* = 86%) playing the peek-a-boo game, and the remaining 14% of the time mothers engaged in game-unrelated behavior. Preliminary analyses revealed that higher perceived stress during pregnancy, but not during the postpartum, was positively correlated with the duration of the play session (r = .260, p = .031), and negatively correlated with the frequency of game-unrelated behavior (r = -.227, p = .030). There were no associations between maternal perceived stress and her use of basic nor optional game phases.

We found preliminary evidence for a relationship between maternal perceived stress and her playful behavior. Our findings suggest that mothers who experienced higher stress during pregnancy may find the fixed structure of the peek-a-boo game enjoyable and thus not only spent more time engaging in this game, but also engaged in less game-unrelated behavior. Interestingly, maternal perceived stress during pregnancy or the postpartum was unrelated to how she structured the peek-a-boo game. Further analyses will probe into the found associations to examine the effects of variables that could modulate early playful interactions between mothers and their infants, such as infant temperament or maternal perinatal depression and anxiety.

Abstract 6, Prenatal stress association with unpredictable maternal sensory signals:

Maternal behavior is crucial in shaping the emotional and behavioral outcomes in offspring. Maternal sensory signals (e.g., tactile, auditory, and visual stimulations) during mother-infant interactions could influence developing neural circuits and therefore neurobehavioral outcomes in infants. In fact, unpredictability in maternal sensory signals was found to be associated with poor cognitive performance and effortful control in children (Davis et al., 2017). Prenatal stress is also a strong predictor of unfavourable neurobehavioral outcomes in children, which could be moderated by maternal caregiving. However, no studies have examined the relationship between maternal prenatal stress and the predictability of maternal sensory signals to her child. The aim of this study was to investigate the association between stress during pregnancy and unpredictable maternal behavior in a high-risk population of teen mothers, who usually face more stress and have a higher risk for mental health issues and worse mental health outcomes for their children (Hodgkinson et al., 2014).

We analysed data collected from pregnant women between 14-19 years of age (n=65) recruited from Departments of Obstetrics and Gynecology at Columbia University between 2009-2012. Women answered the Perceived Stress Scale (PSS) questionnaire at three time points during their pregnancy: T1 = 13–16 gestation weeks (GA); T2 = 24-27 GA; and T3 = 34-37 GA. Maternal sensory signals were coded at 4 and 14 months postpartum of a 10-minute free play session during a laboratory visit. The sequence of behaviors was exported and the probability of transitioning from one behaviour to another was used to calculate entropy rate as a measure of predictability of maternal behavior.

We found that higher PSS scores during the T3 time point were associated with higher entropy rate at the 4-month (p = .04), but not the 14-month visit.

This is the first study reporting a link between prenatal stress and maternal unpredictable behavior in teen mothers. Future studies need to investigate the effect of this relationship on child cognitive and behavioral outcomes.

Abstract 7, Title: Maternal and Paternal Prenatal Experiences: Implications for Parenting and Infant Reactivity/Regulation

Abstract 7, Text:

Maternal anger/hostility may be a transdiagnostic marker of vulnerability for a host of nonoptimal outcomes for mothers and infants across the pre-to-postnatal period (Eiden et al., 2011; Ostlund et al., 2021), particularly in the context of pre-to-postnatal substance use. In addition, an emerging body of evidence suggests that exposure to maternal mood unpredictability (MU) during pregnancy is associated with nonoptimal outcomes throughout childhood (Glynn et al., 2019; Howland et al., 2021; Lin et al., 2019; Ostlund et al., 2019). However, most studies have examined unpredictability in stress, anxiety, and depressive symptoms, leaving a gap in our understanding of MU in anger/hostility (MUA), especially in the context of prenatal substance use as mothers attempt to cut down or quit. Recent work suggests that pregnant women who used tobacco or co-used tobacco and cannabis experienced higher levels of anger/hostility and less of a decrease in anger/hostility throughout infancy (Ostlund et al., 2021), but the role of MUA is unclear. We examined a conceptual model linking prenatal substance exposure, average level of anger/hostility, and MUA with increased infant-toddler reactivity both directly, and indirectly, via postnatal exposure and mood variables (see Figure 1).

Racially diverse, mostly low-income mother-child dyads (N = 247) were recruited in pregnancy and oversampled for prenatal tobacco use based on maternal self-reports and mother-infant biomarkers (n = 81 used tobacco only; n = 97 co-used tobacco & cannabis; n = 69 were demographically similar non-substance-using mothers; 51% Black, 31% White, 24% Hispanic/Latine). Maternal anger/hostility (BPAQ; Buss & Perry, 1992) was measured prenatally and at 2-, 9-, and 16-months of infant age. We applied Shannon's entropy to the item distribution of the BPAQ at each timepoint and averaged measurements to create prenatal and postnatal MUA scores. Maternal reports (MR) of infant reactivity were assessed using the Infant Behavior Questionnaire (9 months; Gartstein & Rothbart, 2003) and toddler reactivity using the Toddler Behavior Assessment Questionnaire (16 months; Goldsmith, 1996). The arm restraint paradigm was used as a laboratory measure of behavioral reactivity (anger, struggle, and distress intensity; Goldsmith & Rothbart, 1999).

Results from path analysis indicated an excellent fit to the data (results are depicted in Figure 2). Higher prenatal anger/hostility predicted higher infant reactivity; co-exposure to tobacco and cannabis predicted lower infant reactivity based on MR. More prenatal MUA predicted higher infant behavioral reactivity. We found significant indirect associations between: maternal prenatal anger/hostility and toddler MR reactivity via infant MR reactivity, β = .10, 95% CI [.05, .17]; maternal prenatal tobacco-cannabis co-exposure and toddler MR reactivity via postnatal cannabis exposure, β = .05, 95% CI [.01, .10]; and maternal prenatal MUA and toddler behavioral reactivity via infant behavioral reactivity, β = .05, 95% CI [.01, .10]. The present study provides evidence that unpredictability in prenatal anger/hostility is a novel predictor of infant and toddler reactivity. Findings also provide support for

prenatal anger/hostility as an important predictor of infant and toddler outcomes. Finally, findings provide further evidence that prenatal co-exposure and continued postnatal cannabis exposure impact infant and toddler socioemotional outcomes.

S.15 Learning By the Book: How Visual and Linguistic Regularities in Infant Storybooks Support Language Development

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Summary

Shared book reading is beneficial to language development by, e.g., increasing conversational turn taking as parent-infant dyads elaborate on the story and pictures. However, less understood is how regularities in the books themselves can support language development. This symposium brings together three talks featuring diverse methods and participants highlighting different regularities in books that could facilitate learning. Talk one assesses visual regularities in books, finding co-occurrence of words and their pictured referents. Talk two compares color and spatial word frequency in books and speech, showing these difficult-to-learn words are more frequent in books. Talk three examines English and Spanish in bilingual books and parent talk during book reading, revealing frequent textual codeswitching and parent switches into Spanish. The discussant, an expert in language development and book reading, will discuss mechanisms of learning from books pulling together talk findings.

Details

Abstract 1, Title: Picturing words in children's picture books.

The value of picture book reading in promoting vocabulary development is well-established (Horst & Houston-Price, 2015). Although considerable research has delved into the ways in which the linguistic and social dimensions of picture books and picture-book reading support word learning (Fletcher & Reese, 2005; Noble et al., 2018), the potential for their visual properties to support learning is much less explored. The current study takes one step towards understanding the role of the visual world of picture books for word learning by assessing the informativity of commonly-read picture book scenes for word-to-meaning mappings. Of primary interest is to examine whether the visual referents in picture books possess three hallmarks known to support children's word learning: (1) frequent word-referent co-presence (Bergelson & Swingley, 2013), (2) precise temporal alignment of words to their referents (Trueswell et al., 2016), and (3) increased informativity for the youngest learners (Rowe & Snow, 2020).

Methods

We analyzed 124 picture books commonly read to young children (Cameron-Faulkner & Noble, 2013; Hudson et al., 2016; Montag et al., 2015; Wagner, 2013), which were then classified as 'Young Books' (targeting 0-3-year-olds, N = 64) and 'Old Books' (targeting 4-8-year-olds, N = 64). Across books, we identified 3968 noun events and examined whether the referents of those nouns were visible both on the page the noun occurred (Timepoint N), as well as on the five pages before and five pages after the noun occurred (Figure 1).

Results & Discussion

Our findings highlight three key trends of how words in picture books co-occur with their referents. First, the mean proportion of matching noun-referent events across the pages of each book ('Observed Scores'; M = 0.74, SD = 0.21) surpassed chance expectations (based on random shuffling of noun events and presence of visual referents; 'Baseline Scores'; M = 0.46, SD = 0.22; β = 0.03, $p < 0.001$; Figure 2A). Moreover, Observed Scores were also within the 60-85% copresence range found in child-directed speech (Bergelson & Swingley, 2013; Trueswell et al., 2016), suggesting that copresence is "high" and similar across contexts. Second, nouns and their referents were well aligned in timing, with referent presence high on the exact page featuring the noun, as opposed to the pages before (M = 0.39, SD = 0.23; β = -0.29, $p < 0.001$) or after (M= 0.45, = 0.23; β = 0.25, $p < 0.001$; Figure 2C). This pattern aligns with the optimal timing for promoting word identification in parent-child interactions (Trueswell et al., 2016; Whitehurst et al., 1982). Lastly, Young Books (M = 0.04, SD = 0.04) displayed a slightly larger difference in scores compared to Older Books (M = 0.03, SD = 0.01): β = 0.006, $p < 0.05$ (Figure 2B). Although present across target audiences, the slightly higher peak at Timepoint N in Young Books (Figure 2C) suggests an attunement in their visual world, offering clearer and more timely cues crucial for early word learning (Yu & Smith, 2012), in contrast to the context-removed language that benefits older children (Rowe, 2012).

Abstract 2, Title: Spatial and Color Words are More Prevalent in Storybooks than Speech

There is a tight relationship between the words infants hear and the words they come to produce. For example, infants who hear more spatial language learn more spatial words (Pruden et al., 2011). In addition to the language infants hear from speech, they are also exposed to other sources of language, include written language during shared book-reading. The language in storybooks differs from that in speech in that storybooks are more lexically diverse and syntactically complex than infant-directed speech (IDS; e.g., Montag et al, 2015). However, it remains unknown whether there are also differences in the prevalence of specific types of vocabulary. To begin answering this question, we investigate two categories of words that have protracted developmental trajectories—color and spatial words. Specifically, infants first learn that color words (e.g., blue/red) belong to a class but have to refine their mappings of words to hues over time (Sandhofer & Smith, 1999). Similarly, infants first comprehend and produce spatial words (e.g., by/high) in highly prototypical contexts before using them more flexibly (e.g., only calling the cup "by" the sink when it is nearly touching the sink; Lorenz & Plumert, 2019). Here, we compare the frequency of color and spatial words in storybooks and IDS.

We calculated the frequency of the 20 spatial words and 8 color words that appear on the MacArthur-Bates Communicative Development Inventory (MBCDI; Fenson et al., 1994), a normed list of words most infants produce before 30-months-of-age. Storybook frequencies came from a corpus of 100 common picture books (generated by Montag et al., 2015). IDS frequencies came from CHILDES (MacWhinney, 2000; Baath, 2010).

We used mixed-effects regression to predict the frequency of each word from its type (color or spatial), corpus (storybooks, CHILDES), the interaction between type and corpus, and age of acquisition (AOA, based on MBCDI norms). The model also included a random item intercept. There was a significant association between AOA and frequency, $X^2(1)=8.17$, $p=.004$, such that earlier-learned words were more frequent than later-learned words. There was an interaction between corpus and type, $X^2(1)=4.21$, $p=.040$. Follow-up analyses revealed that both color words, $X^2(1)=23.47$, $p<.00001$, and spatial words, $X^2(1)=16.20$, $p<.00001$, were significantly more frequent in storybooks than in IDS. To confirm that this difference in the frequency of color and spatial words in storybooks and speech is not universal across all vocabulary, we examined whether there was a similar pattern in the relative frequency of early words—the 13 first learned words on the MBCDI, excluding onomatopoeia. In this follow-up analysis we found that the frequency of early words did not differ across storybooks and IDS, $p>.20$. See Figure 1.

Taken together, our results suggest that storybooks can be informative linguistic sources for specific word categories, including color and spatial words. Given the complex trajectory for color and spatial words, and that acquisition of spatial words might have significant implications for STEM skills in elementary school, identifying relevant linguistic sources to support acquisition of these words will have consequences for support infants long term development.

Abstract 3, Title: Codeswitching in bilingual picture books and shared reading interactions

Books offer children experience distinct from what they encounter in spoken language (Montag et al., 2015). Bilingual books, which present text in two languages, have been increasing in popularity (Domke, 2018), and can provide rich opportunities for learning two languages from the text (Read et al., 2021), as well as from the language produced during shared reading (extratextual talk; Brouillard et al., 2020; Sénéchal & LeFevre, 2020). Although switching between languages (codeswitching) is a relatively common feature of the input that bilingual children hear (Bail et al., 2015; Kremin et al., 2021), we know little about codeswitching within the text in bilingual books and the extratextual talk that bilingual infants and children experience during shared reading. In Study 1, we assess codeswitching in the text of two different types of Spanish/English bilingual picture books: Translation books, which present the narrative text in both languages, and Codeswitching books, which present English and Spanish intermixed. In Study 2, we provide the first comparison of extratextual talk by bilingual parents during shared reading with their toddlers across two book formats: an English-only and a Codeswitching book.

Study 1 compared two age-matched corpora of Spanish/English bilingual books (Codeswitching vs. Translation books, $N = 39$ each, target age: 0-9 years). Books were transcribed and analyzed for 2 types of codeswitches: within-utterance switches, where English and Spanish words are used in a single utterance, and between-utterance switches, where a language change happens at an utterance boundary. Results showed that Codeswitching books included significantly more within-utterance switches [Codeswitching: $M=27.8$, $SD=14.9$, Translation: $M=2.8$, $SD=5.5$, $W=96$, $p<.001$], but fewer between-utterance switches [Codeswitching: $M = 5.7$, $SD = 5.7$, Translation: $M=22.3$, $SD=25.3$; $W=1367.5$, $p<.001$] than Translation books. While both types of books included more frequent changes in language than has been described in child-directed spoken language, the type of switching that occurred most often differed across books (Fig. 1A and 1B).

In Study 2, we video-recorded Spanish-English bilingual parent-toddler dyads ($N=43$) in their homes. Parents read an English book and a Codeswitching book to their toddler ($M_{age} = 3.8$ years, $SD = 0.51$). Parents' extratextual talk (beyond the text) was transcribed and coded for frequency of codeswitches

(ongoing, *N* = 6 to date). A codeswitch was counted when parents provided extratextual talk in Spanish immediately following reading of English text. Results showed that parents codeswitched frequently for the English-only book (*M* = 6.33, *SD* = 5.16) and even more often for the Codeswitching book [*M* = 11.2, *SD* = 5.71, *t*(5) = -2.78, *p* = 0.039; Fig. 1C]. This suggests that bilingual parents frequently switch into Spanish while reading with their toddlers, especially when reading a bilingual book.

Thus, we provide the first evidence that reading bilingual picture books may offer toddlers dense exposure to a uniquely bilingual language experience: codeswitching, which occurs both within the text and in parents' speech. Findings have implications for understanding how the regularities within different types of bilingual books and reading interactions can shape early bilingual language development.

S. 16 Cutting-edge tools in EEG applied to speech processing

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Summary

Currently, the renewed interest in applying EEG to study early speech processing is accompanied by challenges in understanding its underlying neural mechanisms. This symposium aims to provide insights into the strengths and potential pitfalls of recent methodological advances applied to non-repetitive and dynamic speech in early development, to facilitate informed use in different settings, from controlled ones to naturalistic social interactions. The first two presentations will address differences in experimental designs when selecting speech-brain tracking methods and how the brain adapts to speech stimuli at birth, guided by inherent linguistic adaptations, through phase precession. The last two presentations will address speech tracking during naturalistic interactions with the caregiver. This symposium aims to uncover innovative methodologies applied to speech processing, delve into neural mechanisms, and equip participants with useful frameworks for applying these techniques.

Details

Abstract 1 Title: Methodological Insights into Cortical Tracking of Speech in Infancy: What is the Most Optimal Measure for Your Sample?

In the last few years, research has focused on understanding how neural activity in the developing brain tracks information in the external stimuli. In the domain of speech processing, this refers to the mechanism of cortical tracking of speech – the neural processes in the brain that allow it to follow and encode the temporal and spectral features of auditory stimuli associated with speech. This mechanism has been proposed to play a significant role in the processing and encoding of continuous speech, and individual differences in cortical tracking have been linked to language outcomes in young infants. The increasing interest in this mechanism has been accompanied by significant methodological advances related to collecting and analysing data from cortical tracking measures from young infants.

In cortical tracking paradigms, infants are exposed either to short individual sentences or to continuous speech while their continuous neural activity is recorded using electroencephalography (EEG) or magnetoencephalography (MEG). The choice of stimulus type is not trivial as it will influence the optimal data analysis techniques. In this talk, we will discuss different methodologies for the analysis of cortical tracking data applied to two datasets where infants were presented with isolated sentences vs. continuous speech. The first dataset includes Basque monolingual 9-month-old infants (N = 32), and the second dataset includes Basque-Spanish bilingual 10-month-old infants (N = 37). The 9 month-olds were presented with continuous passages of a children's Basque story in infant-directed speech. The 10 month-old bilinguals were presented with isolated sentences in Basque infant-directed speech. The data analysis methods that we will discuss include: 1) Classic time-domain analyses, such as phase synchronization (phase-locking value), which offer insights into the precise timing of neural responses relative to speech events. 2) Frequency domain analyses, such as power analyses to analyze the intensity of neural oscillations across different frequency bands in response to speech. 3) Synchronization analyses, such as coherence, to measure the degree of synchronization between neural oscillations and speech signals across different frequencies at given time points. 4) Linear decoders, such as multivariate Temporal Response Function models (mTRFs) to describe how an input and output of a system are related via linear convolution.
We will argue that the nature of the experimental paradigm significantly influences synchronization outcomes, affecting the interpretation and generalizability of findings. Continuous speech, reflective of natural language processing, introduces complexities in analysis, requiring also careful consideration of practicalities with infant testing and long recordings. In contrast, isolated sentences provide controlled conditions but may not be as suitable as continuous speech for specific synchronization analyses. In summary, our contribution will show how different methods may be more suitable based on the specific goals of each study and the characteristics of the speech stimuli employed. This overview aims to guide and inform researchers interested in speech-brain tracking calculation methods to enhance the validity and robustness of infant research in the domain of speech processing.

Abstract 2 Title: Linguistic rhythmic structures in the newborn brain: exploring predictive processing through phase precession.

Neural oscillations are a key neural mechanism in speech perception and language processing in adults (Giraud & Poeppel 2012; Peelle, Gross & Davis, 2013). Oscillations allow the brain to entrain to different linguistic units such as phonemes, syllables, phrases, simultaneously. Given their regularity, oscillations also offer a natural way to predict future events in (quasi-)rhythmic stimuli such as language. Indeed, the brain has been shown to form predictions about upcoming events (Auksztulewicz et al., 2018; Morillon & Schroeder, 2015). Hence, as speech perception arises from the dynamic sampling of acoustic information at multiple time scales (Morillon & Schroeder 2015), the ability to predict upcoming events may facilitate the encoding of linguistic stimuli (Kujala et al 2023). Studies show that these predictions accelerate processing of quasi-rhythmic stimuli in adults, enhancing the encoding of repeated information (Teng et al., 2020). This results in a faster encoding of characteristics, leading to earlier response onsets, termed "precession" (Teng et al., 2020). The developmental origins of predictive precession have not yet been explored. In this study, we investigated whether oscillatory responses change dynamically in newborns upon the repeated presentation of sentences in three different languages: the prenatally heard language, French; an unfamiliar, but rhythmically similar language, Spanish; and an unfamiliar and rhythmically different language, English. We used data from Ortiz et al. (2023), whereby prenatally French-exposed newborns (n=40, age range 1-5 days) heard 100 repetitions

of a sentence in each of these languages, with the order of languages counterbalance across infants, while their brain activation was measured using EEG at 10 electrodes sites known to show auditory and speech-related responses. We first extracted peak frequencies over aperiodic components (Donoghue et al., 2020), across the delta and theta bands from newborns' EEG power spectrum densities. After detrending, we calculated the cross-correlation between the first and last trial averages and extracted the maximum phase lags. In order to investigate the predictive encoding of stimuli across trials, the maximum delay at the fundamental frequency was mapped in radians. Our results show that for the rhythmically dissimilar and unfamiliar language (English), the last trial lags behind the first one by 937.7 rad. For the rhythmically similar unfamiliar language (Spanish) the last trial lags behind the first one by 205.5 rad, while for the native language (French) the lag is of 109.7 rad. Overall, no phase precession is found across languages; instead, we observe gradual slowing. The native language shows less pronounced deceleration, suggesting preserved speech tracking despite fatigue. Conversely, speech-tracking declines more prominently for the other two languages, especially for the rhythmically similar unfamiliar language. The absence of phase precession at birth may stem from immature brain networks underlying the formation of predictions. Nevertheless, the less marked slowing for the native language suggests the presence of specific predictions guiding rhythmic structure encoding, reinforcing rhythm's role in early language acquisition. Finally, through novel methodological perspectives, these findings open interesting avenues for understanding how speech is encoded within brain oscillations and how the complex process of language acquisition takes place.

Abstract 3 Title: Natural Infant-Directed Speech Facilitates Neural Tracking of Prosody

Infants are very social. They interact long before they can produce speech (Bell, 1974). When interacting with infants, adults across many languages use a characteristic register, termed infant-directed speech (IDS) (Soderstrom, 2007). Infants prefer IDS over adult-directed speech (ADS) (Cooper & Aslin, 1990); moreover, IDS assists infants' word segmentation and recognition (Männel & Friederici, 2013; Schreiner & Mani, 2017; Singh et al., 2009). This IDS benefit has been argued to reflect enhanced amplitude modulations at the frequency of prosody (< 3 Hz; Leong et al., 2017), which is critical for word segmentation (Goswami, 2019).

While IDS is known to benefit the electrophysiological processing of speech by infants (Kalashnikova et al., 2018), it remains unclear whether this results specifically from prosody or other factors, such as the syllabic rhythm. To test this, we compared infants' tracking of IDS and ADS at both the prosodic rate (1–2.5 Hz) and the syllable rate (4.5–6.5 Hz). In mother-infant dyads (n = 30), mothers described novel objects to their German-learning 9-month-olds while infants' EEG was recorded. For IDS, parents were instructed to talk to infants as they typically do, while for ADS, mothers described the objects as if speaking with an adult. Phonetic analyses confirmed that pitch features were more prototypically infant-directed in the IDS-condition compared to the ADS-condition (all $p < .005$). Neural tracking of speech was assessed by speech–brain coherence, which measures the synchronization between the EEG and the speech envelope. Higher synchronization between neural activity and speech supports speech processing (for review, see Meyer, 2018; see Fig. 1.1). We expected higher speech–brain coherence at the syllabic and prosodic rates for IDS compared to ADS, indicating increased neural tracking of slow amplitude modulations.

Our analyses revealed significant speech–brain coherence at both syllabic and prosodic rates (both $p < 0.001$), indicating that infants track speech during natural interactions. In addition, we found significantly higher speech–brain coherence for IDS as compared to ADS at the prosodic rate ($p = .002$), but not the syllabic rate ($p = .33$)—indicating that the IDS benefit arises primarily from enhanced

prosody (see Fig. 1.2). Thus, neural tracking is sensitive to parents' speech adaptations during natural interaction. IDS provides 9-month-olds with a specific advantage for processing prosody, as opposed to a general benefit for speech processing. Neural tracking of prosody has been proposed as a potential neural mechanism for infants' word segmentation from continuous speech (Goswami, 2019; Menn et al., 2022). In enhancing prosody, IDS may thus facilitate higher-level inferential processes such as word segmentation.

Abstract 4 Title: Examining speech-brain tracking during naturalistic caregiver-infant object play using mTRF modelling

Previous work examining neural tracking by infants to amplitude modulations in speech has used pre-recorded, continuous, and usually nursery rhyme stimuli (e.g. Attaheri et al., 2022). In everyday infant-directed-speech, however, vocalisations are variable in length, often repetitive and short, and occur in dynamic, interactive exchanges.
Recording infant EEG during free-flowing interactions with their caregiver, we use mTRF modelling to assess speech-brain tracking in naturalistic settings. Given the noisiness of naturalistic data, we test two training approaches: Individual, where models are trained on individual participants' data, and Generic, which pools across the data of all participants. We also test two methods for segmenting speech as inputs to the model. First, to optimise data quantity, we train mTRFs on continuous interaction segments. Second, to reduce the amount of noise, we compute models with each caregiver vocalisation serving as individual inputs.

Forty-six dyads contributed usable data (M=11.14 months; SD=1.30). 32-channel EEG was recorded from infants whilst they engaged in shared table-top play with their caregiver. Vocalisations were identified and categorised into those lasting over 500 or 2000ms.
The amplitude envelope of caregivers' speech was extracted and filtered below 15Hz, and the EEG signal was filtered into delta (1-4Hz), theta (4-8Hz) and alpha (8-12Hz) frequencies. For continuous segmenting, EEG and speech streams were split into equal-length segments, and randomly allotted into 'training' and 'test' sets. For vocal chunking, each caregiver vocalisation was cut out of the EEG and speech time-series and treated as separate data segments.
Individual models were trained by computing a model for each 'training' segment, and averaging across models (Crosse et al., 2016). Predictive accuracy was calculated by convolving the 'test' segment's neural response with the mTRF and calculating the correlation (r) between the speech signal and that predicted by the model. Accuracy values in training and testing were compared to test for overfitting.
Generic model training combined participants' 'training' and 'test' sets, and averaged models across participants. Final model accuracy was computed by convolving each participant's neural response with the averaged inter-participant model.
Observed r values were compared to a permutation distribution, using paired-sample t-tests, created by pairing each infant's EEG signal with a random caregiver's speech stream.

For Individual models, the continuous method revealed significant predictive accuracy values for delta models only (delta, p=0.043; theta, p=0.179; alpha, p=0.930; Fig. 2.1). In the vocal segmenting method, accuracy did not fall above chance at any frequency (ps>0.05). Whilst r values in model testing were lower than model training for all analyses, greatest differences were observed for vocalisations over 2000ms (Fig. 2.1).
Results of the Generic models, with continuous segmenting, indicated significant tracking at theta

frequencies (delta, p=0.195; theta, p=0.018; alpha, p=0.184; Fig. 2.2). Vocal chucking revealed no significant accuracy values (Fig. 2.2). Across all Generic models, r values were very low (<0.008), suggesting poor representations of the relationship between the speech and EEG signal (Cross et al., 2022).

Our findings demonstrate that constructing mTRF models from naturalistic interaction data is most optimal at the individual level, utilising all available data.

S.17 Biobehavioral Measurement of Interactive Dynamics in Infants at Elevated Likelihood for Autism

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Summary

Infant siblings of children with autism spectrum disorder (ASD) are at an elevated likelihood (EL) for ASD and for a myriad of developmental challenges, including social-communication differences and motor delays. Due to the lack of highly sensitive and specific *behaviors* that predict ASD in the first year of life, early identification efforts have turned to the study of *dynamic*, *biological processes*. ASD is a neurodevelopmental disorder that affects development across domains. As such, measures of multiple biobehavioral systems may be the most promising avenue for uncovering biological underpinnings of ASD and pinpointing developmental cascades that lead to specific challenges. This symposium presents four prospective, longitudinal studies that leverage unique measures of infant biobehavioral dynamics (heart rate, behavioral synchrony, cry, movement) of multiple developmental domains (attention, social, vocalization/speech, and motor) in understanding the emergence of ASD in infancy.

Details

Abstract 1: Heart Rate Measures of Attention and RSA in Infants at an Elevated Genetic Likelihood for ASD

Infant sustained attention can be characterized by a deceleration in heart rate that occurs during episodes of looking. More heart rate change during a look has been linked to more active attention and enhanced cognitive processing (Richards, 2010). Respiratory sinus arrhythmia (RSA) is a measure of how respiratory centers modulate the vagal control of the heart, with high RSA reflecting healthy integration of cardiorespiratory systems. Individual differences in RSA are associated with heart rate changes during episodes of sustained attention, suggesting that RSA may also be important for active attention and cognitive processing. For infants at an elevated likelihood (EL) of autism spectrum disorder (ASD), reduced RSA and/or blunted attention-based heart rate changes may be an indicator of the infant's limited capacity to sustain attention to the environment, possibly limiting early social learning opportunities.

In a prospective, longitudinal study of infants at EL (N=43) and low likelihood (LL; N=51) for ASD, we examine resting RSA and heart rate changes during attention from 1-36 months of age. Heart rate was recorded while infants watched videos and interacted with caregivers and objects. Heart rate data was cleaned for noise and periods in between experiments were extracted to obtain an overall measure of resting RSA. To calculate RSA, a continuous wavelet transformation (CWT) from 0.5-1.5 hz was conducted and inverse CWT was calculated as log(var(iCWT)). All experiments were filmed and coded for infant attention. The first 20 seconds after each look were used to calculate heart rate changes during attention. General linear models were used to evaluate resting RSA and heart rate responses across age and between EL and LL groups.

Results show that heart rate significantly decreased and RSA significantly increased with age from 1-36 months (*ps*<.0001). For both models, there was no significant main effect of group (EL vs. LL) and no significant group x age interaction. When EL and LL infants were split into respective "high" and "low" resting RSA groups, general linear models showed a significant likelihood group x RSA group interaction for the effect on heart rate responses (F=5.22, *p*=0.024). Specifically, LL infants with high RSA showed more heart rate change (more deceleration) during attention (F=8.64; *p*=0.005), but LL infants with low RSA showed very little heart rate response during attention (Fig 1). Thus, as previous studies have shown, infants with higher RSA show more heart rate deceleration during attention compared to those with low RSA. Critically, our results show that this was only the case for LL infants. For EL infants, both high-RSA and low-RSA infants showed significantly smaller heart rate responses during attention.

These findings point to a disrupted integration of cardiorespiratory and attention systems in EL infants. Previous work has shown that both RSA and heart rate changes during attention are important for the development of social communication (Bradshaw & Abney, 2021) and this study shows that for EL infants, who are already at a greater likelihood of ASD and social-communicative challenges, there may be a maladaptive disconnect between cardiorespiratory and attentional systems early in development.

Abstract 2: Strange Situation Vocal Characteristics as a Predictor of Attachment Classification for Toddlers at Elevated Likelihood of Autism

Atypical vocalizations are commonly observed in infants who go on to be diagnosed with autism spectrum disorder (ASD), and atypical vocalization qualities are found across the lifespan for individuals with ASD. We previously found children in the current sample later diagnosed with ASD were more likely than children without ASD to be classified as insecure (vs secure) and more likely to be classified as insecure-resistant (versus secure or avoidant) at 15 months of age (Martin et al., 2020). Prince et al. (2021) found that expert ratings of resistance behaviors were associated with increased crying during both reunion episodes of the Strange Situation Procedure (SSP). Given these findings, we examined how objectively-identified toddler vocalizations and cries (and toddler-directed adult vocalizations) during both low and high stress interaction episodes functioned as potential predictors of attachment classification and later ASD diagnosis.

Vocalizations of 15-month-old children with later (36 months) ASD diagnoses (EL/ASD, N=15), and at elevated familial likelihood for ASD without an ASD outcome (EL/No-ASD, N=37) and low-likelihood without later ASD (LL/No-ASD, N=40) were identified during the SSP. Toddler and adult non-cry vocalizations were detected by the Automatic LInguistic unit Count Estimator (ALICE; Rasanen et al., 2021), toddler cries were detected with a SVM classifier using deep spectrum and acoustic features (Micheletti et al., 2022, Yao et al., 2022), and the fundamental frequency (F0; pitch) of vocalizations

were obtained with Praat (Boersma & Weenik, 2023). Based on the 15-month SSP, toddlers were classified as Secure (N = 65), Insecure-Resistant (N=9), or Insecure-Avoidant (N=5), Disorganized (N = 13).

For the sample as a whole, the pitch of adult vocalizations (mean F0) were lower and toddlers exhibited shorter average, total, and proportional cry durations during low stress (Free play) than high stress (Separation with Stranger, Child Alone, Reunion with Parent) SSP episodes. With respect to diagnostic group, adult vocalizations toward toddlers with EL/No-ASD had higher mean F0 than adult vocalizations toward toddlers with LL/No-ASD. For children who cried during the low stress interaction, cry mean F0 was higher for children with EL/ASD than those with EL/No-ASD. With respect to attachment classification, there were no significant group differences in toddler non-cry vocalization mean F0, mean cry duration, or adult vocalization mean F0. However, children with resistant attachment demonstrated significantly greater cry duration than children with secure ($p = .007$) or avoidant ($p = .022$) attachment, $F(3,85) = 4.15$, $p = .008$, $\eta p2 = .128$. No difference in total cry duration was found between children with and without later ASD, $F(1,85) = .065$, $p = .800$, $\eta p2 = .001$. In our sample, greater cry duration predicted attachment classification, which adds to previous evidence that cry duration is as an objective marker for resistant attachment (Prince et al., 2021).

Abstract 3 Dyadic Synchrony and Responsiveness within the Context of Elevated Autism Likelihood: Applying Time-varying Effect Models

The ability to engage in synchronous interactions develops within the first year, as infants learn to sequentially regulate their prosocial behaviors. Difficulties developing competence in these early social building blocks is linked to later developmental concerns, such as autism spectrum disorder (ASD) or language delays. Currently, our metrics for quantifying social competence primarily rely on mean-level indices. However, the nature of an interaction can change in just a few minutes. Thus, to inform our understanding of early social development, the present study modeled the ebb and flow in dyadic synchrony and responsiveness to determine whether unfolding rates of social exchanges are distinguishable by autism-likelihood or developmental concern classification groups.

One hundred and sixty-seven dyads were recruited from families with at least one older child with ASD (elevated ASD likelihood group, n = 95) or families with no history of ASD (typical ASD likelihood group, n = 72). As part of a prospective study, 12-month-old infants and their mothers completed a play interaction. Theory-driven indices of dyadic synchrony (DS), infant responsiveness (IR), and maternal responsiveness (MR) were derived from micro-analytically coded instances of gaze, positive affect, and vocalizations. A series of logistic time-varying effect models (TVEM) were conducted to assess associations between rates of observed synchrony/responsiveness and group status. The first set of models compared elevated and typical ASD likelihood groups and the second set explored differences based on study outcome classifications of typical development, non-ASD developmental concerns (Non-ASD DC), and ASD. Likelihood status models for DS included a total of 21,227 observations (elevated ASD likelihood = 11,886; typical ASD likelihood = 9,341). Developmental classification models included 19,646 observations (ASD = 1,762; Non-ASD DC = 3,960; TYP = 13,924).

Regardless of risk and/or developmental classifications, dyads exhibited relatively stable rates of synchrony and responsiveness (Figure 2). However, a distinct pattern for the Non-ASD DC group was evident. Recognizing the Non-ASD DC group primarily included children with language-specific concerns, this finding may further highlight the active role language development plays in our indices of dyadic

synchrony and responsiveness. Within this study, infants (regardless of group membership) with higher DS, IR, and/or MR at 12 months scored significantly higher on receptive and expressive language scales at 36 months. Overall, this study provides preliminary support for examining social processes over continuous time to provide meaningful context beyond our typical reliance on aggregated behavioral totals.

Abstract 4: Wearable sensor technology to assess motor movements that differentiate infants at familial risk for ASD and ADHD

Autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) are two prevalent neurodevelopmental disorders (NDDs) that manifest in early childhood. Despite being distinct conditions, ASD and ADHD often co-occur and share similar traits. Increasingly, efforts have been made to measure behaviors that present in early life that may be shared or differentiate these two conditions to guide early detection and developmental monitoring. Although motor delays and challenges are often reported in both ASD and ADHD, both as a prodromal symptom feature and manifesting through childhood, early motor differences that may distinguish the two groups have not been yet identified. Quantitative measures of movement variability hold promise for improving the identification of subtle and specific differences in motor function. The ability to generate a complex and variable repertoire of movements in early life is important for healthy neuromotor maturation. Poor variability in motor movements underlies more constricted and repetitive motor movements, core diagnostic features of ASD. Less complex movements may be subtle to detect in infancy and quantitative measures may detect this potential distinct prodromal behavioral feature of ASD5. We created a novel quantitative measure of movement variability and complexity, termed curvature, and investigated whether this measure differentiates toddlers with ASD and ADHD Concerns and improves prediction of infants who later receive a diagnosis of ASD. We hypothesized that infants with a later ASD diagnosis would show lower curvature compared to infants with later ADHD Concerns and those typically developing (TD).

Infants with an older sibling with ASD (high familial risk for ASD) and infants with family history of ADHD (high familial risk for ADHD). At 36 months, participants were categorized into three outcome groups: ASD (n = 19), ADHD Concerns (n = 17), and TD (n = 82). We used a wearable tri-axial accelerometer to evaluate continuous motion-based activity in infants at 12, 18, 24, and 36 months of age during laboratory-based assessments. We constructed a measure, curvature, using the accelerometer time series data. High curvature indicates a more variable acceleration movement pattern generated by an infant. Conversely, low curvature indicates a less variable acceleration movement pattern. To evaluate the predictive utility of curvature with respect to ASD, we used age-stratified logit models with and without adjustment for familial ASD risk. Predictive performance was evaluated using the area under the ROC curve (AUC).

Curvature was significantly lower at 18, 24, and 36 months in infants with later ASD diagnosis compared to infants with ADHD Concerns and TD. Curvature was a valuable predictor of ASD at 18, 24, and 36 months (AUC 0.66-0.71; p = 0.005-0.039). The 18- and 24-month timepoints remained significant after adjusting for familial risk group, adding predictive value over and above baseline familial ASD risk (combined AUC: 0.90, p=0.005-0.019), while the 36-month timepoint was marginally significant (combined AUC: 0.87, p=0.09). Lower movement curvature may be a distinct feature of early motor differences in infants with later ASD compared to ADHD and may underlie the emergence of later movement delays and repetitive movements in this condition.

S.18 Motor development in interplay with the environment: exploring developmental variability and developmental cascades

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Summary

Changes in development occur both within and across multiple domains and are influenced by a constantly changing environment. Indeed, the acquisition of motor skills alters infants' interactions with the environment and experiences with objects, spaces, and people. These changes may have cascading effects on other domains.
This symposium provides new insights into this complex phenomenon in neurodiverse populations and through different methodologies (i.e., observation, novel paradigms, and advanced technologies). Presentation 1 underscores how locomotor development shapes caregiver behavior around spatial construction and interaction in neurotypical infants. Presentations 2 and 3 involve preterm infants. The first points out the role of parents in stimulating infants' object exploration; the second highlights the role of sitting skills in enhancing communication abilities. Presentation 4 shows how sensorimotor abilities constrain language development in children with Down syndrome.

Details

Abstract 1: Building spaces for play: How mothers design and explore new play environments with pre-walking and walking infants

The physical environment is the backdrop for infant development. Indeed, all infant behavior—movement, exploration, social interaction, and communication—occurs in the context of a physical space. Yet researchers know surprisingly little about how the spaces that infants inhabit come to be. For infants, everyday play spaces are typically structured by caregivers. Caregivers choose the objects and furnishings that dress playrooms and living spaces and organize them in particular ways. As infants' postural and locomotor skills develop, however, so does their agency for engaging with the spaces of everyday play and potentially altering them.
Learning to walk, for example, changes how infants interact within the environment. Compared to pre-walking infants, walkers move more, travel more, and spend more time playing at a distance from their caregivers. The cascading effects of walking on other infant behaviors suggest that walking may expand how infants explore and interact with the spaces of everyday life. As a result, caregivers likely update and reconfigure the physical arrangements of infants' spaces to meet their developmental level, structure safe environments for play, and respond to a continually advancing repertoire for action. How do caregivers build spaces for infant play? And does infant motor ability shape the characteristics of the spaces that caregivers construct?
This study introduced a novel paradigm to examine how mothers of pre-walking and walking infants created a new play space and engaged in play in different environments. We observed 52 12-month-old infants (35 pre-walkers, 17 walkers) and their mothers. Mothers were asked to design a playroom using a set of building blocks in an otherwise empty room. We examined relations among infants' locomotor status, mothers' design choices, and patterns of infant and mother behavior during eight minutes of play

in mother-designed playrooms.
Figure 1 illustrates representative playrooms from mothers in both locomotor groups—small, average, and large rooms for pre-walkers (in red) and walkers (in blue). As shown in the figure, mothers built spacious playrooms for pre-walkers (multiple block constructions spanning a large area) and concentrated playrooms for walkers (one to two block constructions covering a small area). There were also group differences in infant activity during play: walkers moved more, traveled more, and engaged in more complex patterns of interpersonal distance to mothers compared to pre-walkers. And although mothers directed similar amounts of language and gesture input to infants during play, they communicated more frequently while infants were moving compared to when they were stationary. Finally, differences in the characteristics of mothers' playrooms (indexed by the built area of the space) only related to one infant behavior: infants generated more room layout changes (i.e., when infants changed the configuration of the playroom by moving a block) when playrooms were larger.
Taken together, this study expands our understanding of how infant motor development shapes caregiver behavior and extends these cascading connections to the domain of caregiver spatial construction. Most importantly, we contribute new insights about the dynamics of infant and caregiver behavior as a process embedded in the context of the physical environment.

Abstract 2: Supporting Preterm Infants' Object Exploration in Parent-Infant Object Interaction at 6 months

Introduction. Preterm infants showed delayed motor development with developmental cascading effects in other domains (di Rosa et al., 2016). For example, preterm infants showed less object exploration at six months, which is linked to poorer performances in language development at two years (Zuccarini et al., 2017). Previous work showed that parents can support gross and fine motor development of preterm infants (e.g., Lobo & Galloway, 2008, 2013), but evidence about scaffolding for object exploration in this population is still scarce.
Aim & Hypotheses. This study investigates how parents of preterm infants can support early object exploration through interaction. We hypothesize that parental object presentation can increase preterm infants' visual and manual engagement with the object and exploratory behaviors.
Study population. Forty preterm parent-infant dyads were assessed at 6 months of corrected age (M = 6.3, SD = 0.4) as part of a preterm follow-up program. The infants (22 females) had a mean gestational age of 29.9 weeks, SD = 2.9, and a mean birth weight of 1241 grams, SD = 390. Recruitment took place at the University Hospital of Bologna, Italy, with the majority of parents (82.5%) being Italian.
Methods. The dyads were observed during a 6-minute semi-structured interactive session with age-appropriate toys. Sessions were videotaped, and parents' and infants' behaviors were coded frame by frame using the Interact software. The coding focused on: a) infants' engagement with the objects; b) infants' object exploratory behaviors; c) caregivers' engagement with objects; d) caregivers' object presentation. Proportional durations were computed for each infant and caregiver behavior.
Results. Data analysis was conducted using IBM SPSS and GSEQ. Infants engaged manually with the object 60% of the time, visually without holding the object 18%, and showed no object engagement for the rest of the time. Object manual engagement was predominantly passive (holding, 40%). The most frequent active object manual engagement was mouthing (12%), followed by manual rhythmic behaviors (4%), fingering (2%), and moving the object (e.g., turning, transferring; 2%). Caregivers spent 50% of the time holding the object in their hand for visual (20%), functional (10%), tactile (1%) presentation or handing the object to the infant (18%); less than 1% of the time, caregivers took the object away from their infant's hand. Correlational analyses showed that caregivers' functional presentation of the objects was positively correlated with infant visual engagement, but negatively

associated with infant manual engagement. Conversely, the absence of object presentation by parents was positively correlated with infants' manual engagement. Temporal analysis of parent-infant interaction showed that infants were more likely to visually engage with the object when parents were presenting it and more likely to initiate manual engagement with the object during the five-second window following object presentation.
Discussion. Findings support the hypothesis that parents, through object presentation, can stimulate preterm infants to focus on and manipulate objects. The correlational findings on the other hand suggest that less parental involvement goes along with more manual activity on the infants' part.

Abstract 3: Relationship between vocal production and sitting acquisition in 6-month-old preterm infants

Introduction. Preterm infants are at risk for neurodevelopmental delays, including delayed motor milestones, posture acquisition, vocal production, and language onset (Ko & Lim, 2023; Oller, et al., 2019). Recent studies on typical and some atypical populations have shown that mastering new motor skills contributes to the development of communication and language abilities (Iverson, 2022), but very few studies have explored the relationship between these skills in preterm infants (Jensen-Willet, 2019). This study aims to investigate the relationship between vocal production and motor development in 6-month-old preterm infants, focusing on sitting acquisition.
Method. Seventy-four very low gestational age and/or very low birth weight preterm infants with no major cerebral damage, sensory or motor impairments (34 females; gestational age: M = 29.8 weeks, SD = 19.3; birth weight: M = 1233 grams, SD = 368) were recruited from University Hospital of Bologna, Italy, and assessed at six months of corrected age. Infants' vocal productions were collected during a video-recorded 7-minute semi-structured mother-infant interaction session, transcribed, and analyzed using CHILDES software. Infants' vocal productions were coded as follows (Buder et al., 2013): Level 0: reflexive sounds; Level 1: phonation-related protophones; Level 2: canonical and reduplicated babbling. Frequency per minute for each category was computed. Motor skills were assessed through the Bayley Scales of Infant and Toddler Development (BSID-III, Bayley, 2006). The Bayley item for unsupported sitting for at least 30 seconds was video-recorded and used to identify such acquisition.
Results. All children produced reflexive sounds (L0), most of them (94.6%) showed protophones (L1), while only 24.3% exhibited babbling (L2). Infants' mean rate per minute consisted mainly of L0 (M = 2.72; SD = 2.14) and L1 (M = 2.79; SD = 2.44) sounds, while L2 was limited (M = 0.08; SD = 0.25). Regarding motor skills, the mean infants' composite motor score was 91.5 (SD = 13.4), gross-motor scaled score 7.4 (SD = 2.5), and fine-motor scaled score 9.7 (SD = 3.3). Concerning unsupported sitting acquisition, 10.8% of the sample maintained it for at least 30 seconds. Spearman correlations showed positive associations between L1 productions and the gross-motor score (r = .23; p = .05), and between L2 productions and the composite motor score (r = .23; p = .05). Infants achieving unsupported sitting for at least 30 seconds produced more vocalizations per minute (L0, L1, L2 sounds) than children not exhibiting such skill yet (ps <. 05).
Conclusions. New evidence is provided on the reciprocal influence between the motor and vocal domains in preterm infants highlighting positive relationships between gross-motor achievements and vocal development and, particularly, between mastered unsupported sitting and vocal productions, including protophones and babbling. These findings emphasize the relevance of assessing specific motor and vocal skills using observation tools, besides developmental scales. This approach can help identify early motor and language delays, and plan tailored interventions for preterm infants.

Abstract 4: Hand-eye coordination constrains receptive vocabulary in young children with Down

syndrome

Introduction & Hypotheses. Young children with Down syndrome (DS) have been described as showing reduced engagement with their physical environment. Compared to their typically developing (TD) peers, children with DS spend less time looking at and manually exploring objects (for review, see D'Souza & D'Souza, 2023). Coordination of these two behaviours, i.e., hand-eye coordination, may be particularly important for creating opportunities for word learning, constraining receptive vocabulary development. Here we utilise head-mounted eye-tracking to examine hand-eye coordination in context within which word learning commonly occurs – free-flowing interaction with objects and a social partner.
Study Population. Fifteen TD young children (17-27 months) were matched on mental age to 15 children with DS (36-58 months).
Methods. Together with their parents, the young children took part in the head-mounted eye-tracking study of parent-child interaction (6 minutes) with novel objects and their labels. The video data was coded frame-by-frame for looking behaviours and object handling. This enabled us to extract instances of child hand-eye coordination (moments when the child both looked at and manually handled the same object). The audio data was transcribed and analysed for the number of labels given by the parent. The parents reported on their child's receptive vocabulary using a customised Communicative Development Inventory (CDI; based on Fenson et al., 2007). Children were also administered the Mullen Scales of Early Learning (MSEL; Mullen, 1995) to measure their mental age.
Results. Contrary to general expectations, there was no difference in the frequency of hand-eye coordination per minute between children with DS (M=14.56, SD=3.50) and TD children (M=14.03, SD=4.54); $t(28)=0.36$, $p=.724$. Similarly, no differences were observed in the proportion of time in hand-eye coordination (DS: M=.36, SD=.10; TD: M=.35, SD=.10; $t(28)=0.19$, $p=.853$). There were also no differences in parental labelling frequency per minute (DS: M=3.99, SD=2.29; TD: M=4.99, SD=4.04; $t(28)=-0.84$, $p=.411$) or receptive vocabulary size (DS: M=331.73, SD=108.69; TD: M=381.67, SD=124.73; $t(28)=-1.17$, $p=.252$).
Next, we examined whether hand-eye coordination constrained receptive vocabulary size. The frequency of hand-eye coordination did not (both groups: $R2<.14$, $F(1,13)<2.10$, $p>.170$). However, the proportion of time spent in this state did (see Fig.1), but only in the DS group ($R2=.27$, $F(1,13)=4.78$, $p=.048$) and not in the TD group ($R2<.01$, $F(1,13)=0.06$, $p=.814$). Interestingly, the number of labels per minute parents provided did not explain a significant proportion of variance in receptive vocabulary in either group (both: $R2<.04$, $F(1,13)<0.51$, $p>.490$).
Discussion. In sum, despite no general group differences, we found support for alternative developmental pathways. Specifically, children with DS who spent more time jointly handling and visually attending objects had greater receptive vocabulary. This supports an interpretation that hand-eye coordination plays a crucial role in forming representations of objects which can then be paired with auditory labels. It is possible that children with learning disability, which is common in children with DS, rely on this developmental process for a prolonged period. This line of research will inform our theories of language development as well as provide insights for parents and practitioners into how to better support young children with DS.

S.19 Emergence of socio-cognitive development: Focus on neural-physiological-behavioural dynamics in mother-infant interactions

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Summary

Human social cognition is developed with diverse trajectories. An infant's internal senses (interoception) are integrated with multimodal information from outside the body (exteroception), particularly through daily interactions with caregivers. The social brain is believed to be driven by these experiences. It is also important that caregivers are influenced by interactional experiences, leading to changes in the mechanisms of further interactions. Therefore, this symposium presents cutting-edge methods for analysing mother-infant interactions. We discuss the diversity of social cognitive development from an open systems science approach, with focus on how we can visualise the dynamics of mother-infant interactions through multiple organ layers such as the gut microbiota, autonomic nervous system, neural brain system and behaviours. Overall, this symposium will help us better understand the development of diverse social cognition, including cultural and individual differences.

Details

Abstract 1: Dyadic Sociometrics: Precision Assessment of Early Parent-Child Social Interaction to Predict Early Cognitive Development

During early life, healthy neurodevelopment depends on warm, responsive and closely-coordinated social interactions between infants and caregivers. These rich multidimensional sensory experiences act through diverse neurophysiological pathways and at multiple timescales to orchestrate healthy maturation of the neonatal brain, mind and body. Conversely, adverse early life experiences seed vulnerabilities for poor cognition and emotional instability throughout the lifespan.

Despite the pivotal role played by caregiver interactions in early development, we still lack medical models and precision tools that can accurately and objectively assess a child's social environment and interactive capacities (their ability to engage in and respond to social input). Specifically, social interaction indices are not typically tracked at a millisecond timescale that is compatible with fine-grained neural measurements, such as electroencephalography (EEG). This potentially misses real-time neural-social dynamics between caregiver and infant that could be sensitive for the prediction of emerging neurocognitive capacities. At the same time, although psychological tools exist to measure older children's cognitive capacities – including executive function (EF) skills and precursors such as attention, working memory, cognitive flexibility and inhibitory control – most of these tests cannot be used in the first year of life to measure nascent infant abilities. Therefore, a needs gap currently exists in the (1) precision measurement of caregiver-infant social and neural dynamics, (2) early measurement of infant EF skills, and (3) their relationship. The lack of such measurement tools also means that we currently miss early warning signs of suboptimal psychosocial development, along with valuable opportunities for prophylactic intervention, before a child's first birthday.

To address this gap, here we will describe Dyadic Sociometrics – a methodological approach utilising multimodal sensor technologies (to collect dyadic measures of brain activity, heartrate, gaze, speech, emotion and pose from parent and child) and machine learning algorithms (for automatic labelling and predictive modelling). Collectively, these technologies permit multimodal precision assessment of adult-infant social interactive behaviour during performance of cognitive tasks by infants. In a cohort of N=58 Singapore infants (mean age = 512.28, SD=162.02), we find that dyadic sociometric measures are able to

predict precursors of developing executive function with up to 86.7% accuracy using a combination of indices from audio, emotion and neural domains, whilst 83.7% prediction accuracy can be obtained with audio indices alone. These predictive tools pave the way for early risk identification and mitigation, paired with precision therapeutics, could fundamentally alter a child's development trajectory toward lifelong mental wellbeing and productivity.

Abstract 2: Mother–infant one-on-one social interactions at 3 months are associated with infants' productive language development in the third year of life

Previous studies underscore the importance of early social interactions for child language development, specifically interactions that are characterized by maternal sensitivity to the infant as well as infant-directed speech (IDS) and conversational turn-taking (CT) in one-on-one context. Although infants are engaged in face-to-face interactions with their caregiver including conversation-like exchanges from the third month after birth, there is little data on the potential link between speech input and maternal sensitivity prior to 6 months of age and later language development. We hypothesize that early social interactions, before the classic "sensitive period" characterized by sensitivity, IDS and CTs, are associated with language development.

Using a sample of 40 3-month-olds, we assessed maternal sensitivity, using mother–infant one-on-one (1:1) interaction in the lab for later offline behavioral coding using a well-validated scoring system (Coding Interactive Behavior, CIB). The language input variables were assessed at home using digital first-person perspective recordings of the infants' auditory environment (Language ENvironment Analysis system, LENA) as they went about their daily lives. Language outcome measures were assessed when participants reached the age of 18 months and continued to 30 months of age using the MacArthur-Bates Communicative Development Inventory (CDI).

We found that maternal sensitivity, CTs and IDS during mother–infant 1:1 interaction at 3 months of age are significantly correlated with later language development scores. We hypothesize that one mechanism by which infant-caregiver interactions during this early period support language development is increased infants' attention to speech. In infants, attention and orienting responses are associated with heart rate deceleration. In a subsample of 31 3-month-olds we also measured ECG during an additional mother–infant 1:1 interaction. We found that higher maternal IDS and CTs in the home environment are associated with lower infants' heart rate measured during mother-infant interaction at the lab. Interestingly, we found that infants' heart rate at 3 months of age is correlated with later language development scores, such that lower heart rates are associated with higher language development scores.

These findings support the hypothesis that infants' social attention to speech during this early period may play a role in advancing language development. In addition to behavioral and physiological measures during mother-infant one-on-one interaction, future research should investigate brain-to-brain synchrony and infant neural responses at 3 months of age during mother-infant interaction. It will be theoretically informative to examine whether neural synchrony at 3 months of age is associated with speech input and later language development.

Abstract 3: The microbiome-gut-brain axis in human infants and their mothers related to the development of emotion regulation

The human gut microbiota reaches an important stage of maturation by 3–5 years of age and is strongly influenced by various environmental factors, including family members. In recent years, based on the microbiota-gut-brain axis perspective, the gut microbiota has been shown to be not only associated with physical disease, but also with mental disorders (e.g. depression). Additionally, the gut microbiota influences vagal activity, which affects self-regulation mediated by the prefrontal-limbic system. Meanwhile, human infants develop their autonomic nervous systems (ANS) through caregivers' regulation (e.g. the regulation of temperature, heart rate, sleep, arousal, etc.) in their daily interactions. Thus, it is important to examine the relationship between the human gut microbiota, the ANS and cognitive-behavioural development in both mothers and infants.

For this purpose, the present study analysed 49 mother-infant pairs (infant age: 35.84 months, SD = 4.13; mother age: 41.08 years, SD = 3.18). Specifically, the mothers were asked to provide faecal samples, offer three days of continuous electrocardiography (using a Holter monitor (Heartenote®)) and complete questionnaires at their home. From the faecal samples, we evaluated the alpha and beta diversity of the gut microbiota and the composition of the predominant microbiota by 16S rRNA analysis. Regarding the ANS, we examined cardiac sympathetic indices (CSI) and cardiac vagal indices (CVI) through an electrocardiogram and questionnaires. Moreover, we assessed the social and emotional behavioural development of the infants (e.g. emotion regulation, positive/negative emotional expression, etc.) as well as the parenting stress of the mothers through questionnaires.

Based on the findings, the alpha diversity of the gut microbiota is significantly related among the mother-infant pairs ($r = 0.54$, $p < 0.001$). As for the infants' microbiome diversity (Shannon α), it is related to their CVI ($r = 0.42$, $p = 0.003$) and CSI ($r = -0.44$, $p = 0.001$). Meanwhile, their CVI is related to socio-emotional reactivity, especially negative emotion expression ($r = -0.31$, $p = 0.028$) and positive emotion expression during play ($r = 0.32$, $p = 0.024$). Regarding the effect of parental stress, the infants of high-stressed mothers showed higher risk in the development of executive functions, including emotion regulation as well as higher expression of negative emotions and stress responses than those of low-stressed mothers. Furthermore, the infants of high-stressed mothers showed lower CVI and significant differences in some gut microbiota such as Colidextribacter and Blautia, (all ps < 0.05).

Overall, the findings indicate that the microbiota-gut-brain axis is apparent by at least 3 years of age and is related to children's emotional-cognitive development. Meanwhile, maternal stress has a significant impact on the child, not only on social cognitive development, but also on the development of the ANS and gut microbiota, which provide the neurophysiological basis for social cognitive development. Further research is necessary to identify the associated factors, including physical symptoms, diet and lifestyle. This study provides insights into developing methodologies of helping mothers and their children maintain good mental and physical development by considering individual differences in gut microbiota and improving their daily lifestyle.

Abstract 4: Framework for Behavioural Synchronicity Measurements in Parent-Infant Dyads in Naturalistic and Experimental Settings Using Motion Capture

Recent developments have allowed the measurement of neural and physiological synchronicity between parents and infants across different layers– brain, heartbeat, endocrine hormones, microbiota, etc. However, due to the inherent difficulties of human motion capture (esp. in infants), inherent variability between dyads, and the richness of positional data (4D data), measurements of behavioural synchronicity are still lagging behind, relying on subjective ratings or simple measurements of motion.

Here, we propose a methodological framework to quantitatively measure parent-infant interbody behavioural synchronicity across different motion-based metrics, using marker-less motion capture technologies. We also applied this framework to both naturalistic and experimental settings.

Using an array of three RGB + Depth cameras, we recorded mother – infant (6 – 8 months) dyadic interactions in naturalistic and experimental settings. The naturalistic setting was music appreciation experience and the experimental one was the still-face paradigm. From the video data, we extracted 4D ([X, Y, Z] plus time) positional data of different body points (joints), as well as a rich set of facial points, from the captured bodies the participants.

Using the extracted joint data, we were able to calculate accurate 3D-world-coordinate joint positions for both the mother and the infant with a high degree of success. From these coordinates, we calculated position derivatives (i.e., speed, acceleration, jerk) to obtain meaningful correlation measurements between mother and infant (e.g., kinetic energy correlation). Further, we also calculated more complex measurements of synchronicity (e.g., wavelet coherence), as those used with EEG signals. Finally, using the movements of the participants, we could define specific events (e.g., “mother approaches infant”, or “infant looks directly at mother”) to perform event-based analysis to address the issue with the variability in movements across dyads.

Here, we present a relatively inexpensive motion capture setup and the associated methodological framework for processing and analysing the motion data. Although behavioural data have been widely used to measure parent-infant dynamics, in-depth quantitative analyses have been lacking until recently. The proposed framework provides a wealth of quantitative data, making it possible to build on previous findings based on lengthy subjective coding, both in terms of validity and the ability to scale up the number of recordings. The measures proposed here mirror those used in other modalities (e.g. EEG) to measure dyadic synchrony, provide both a quantitative and meaningful representation of behaviour, and could extend the field of parent-infant dynamics in new directions.

S.20 Predictive processing in early development

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Summary

The idea that the brain generates predictions to efficiently perceive and navigate the world is one of the prevailing models of brain function. While current theories deem predictive processing as drivers of cognitive development, there are important open theoretical questions and a lack of knowledge about predictive processes in early development. This symposium synthezises some of the latest theoretical and empirical advances. First, predictive processing is introduced and current limitations from a developmental perspective are highlighted. Two crucial adaptations to the predictive processing framework are proposed, the definition of a starting point and a conceptual toolkit that allows the investigation of new causal links within the model. Second, implications of the predictive processing account for cultural learning and social norms are being discussed, including empirical works that demonstrate a crucial role of predictive processes in socio-cognitive development in the first postnatal year. Third, the role of predictions and top-down modulation in perceptual development is introduced.

Computational learning models are used to show how infants' prefrontal cortex tracks complex patterns in the environment and how it interacts with sensory systems. Finally, a common problem in infancy research is addressed, namely the confounding of prediction error with the presentation of unexpected input, by testing prediction errors to the omission of expected input. These approaches are proposed to allow brain responses to be explained by prediction alone. Taken together, this symposium will provide a multifaceted and state-of the-art overview on how the predictive processing framework may advance our conception and study on early development.

Abstract 1: Beyond the Adult Mind: A Developmental Framework for Predictive Processing in Infancy

Predictive Processing has been proposed as the single unifying computation underlying all of cognition, and proponents argue that all psychological phenomena can be explained as consequences of this mechanism. The mechanism consists of maintaining mental models of the world, which are built through the comparison between incoming sensory input and the expected input based on previous experience. This process of comparison is done in service of a single proposed goal: reducing uncertainty about the world by updating expectations and building ever more accurate predictions of future input. Predictive Processing has inspired many cognitive scientists and neuroscientists, but it currently has no developmental mechanism that would explain how infants begin to build such mental models. Specifically, Predictive Processing only allows for perception of incoming stimuli given the existence of expectations based on previous experiences, and only allows for incremental updating of expectations without the possibility of creating new categories or causal links within the models. As such, it does not allow for an infant to ever make a first observation, unless the mental model is already pre-specified with all possible categories and causal links already in place. This is a fundamental limitation of the theory, as it claims that these mental models are necessary for perceiving and learning about the world. Therefore, in its current form, Predictive Processing treats human cognition as if it exists in a fully-developed adult with a history of observations and world knowledge. In this talk, we will first describe the key elements of the Predictive Processing framework as an introduction for those unfamiliar with the terminology. We then propose two crucial adjustments to the original framework to begin to build a developmental Predictive Processing. We first define a possible starting point from which the infant can begin to develop predictive models, and then describe a toolkit necessary to allow the infant to perform the range of cognitive operations on predictive models necessary for learning. The starting point we propose is a set of mental models without hierarchical organisation, and with some basic expectations about the possible sensory input, for example, an early bias to the top half of the visual field and to motion. The toolkit we propose contains a range of operations referred to collectively as structure learning, which are applied to allow for processes like forming new categories and adding new causal links within the model, amongst others. This toolkit is necessary for all learners, but most conspicuously in the case of infants starting to perceive and learn about the world with very few existing expectations, categories, and causal links. We explain how the early models from our starting point could be used along with the toolkit we propose in order to scaffold the construction of adult-like models. These modifications are necessary for developmental scientists to be able to adopt the Predictive Processing framework and benefit from its advantages, but also for Predictive Processing to be able to explain all human cognition, which inherently must include development.

Abstract 2: Reducing entropy in the social world: A predictive processing perspective on early cultural learning and normativity

For any living organism, forming predictive models to reduce uncertainty (i.e., entropy) in the environment, is core to successful navigation and survival. How does the predictive processing framework inform our understanding of human early development, being able to adapt to and survive in the most versatile habitats on the planet? Human flexible adaptation relies on the acquisition of culture and social norms, rather than on genetically determined cognitive and behavioral repertoires alone. I argue that culture and norms have (co-)evolved with human capacities for flexible adaptation, to reduce the entropy in complex ecologies and social environments. That is, from a predictive processing perspective culture and norms may function as predictive models, socially transmitted behavioral structures that reduce uncertainties in diverse and complex human lifeworlds, and thereby enable human flexible and efficient adaptation. Based on this perspective, cultural learning and normativity should emerge early in ontogeny, allowing developing humans to make sense of their social world and meet the complex affordances of their specific environment. This proposal is corroborated by findings form developmental psychology, suggesting that cultural learning and an implicit normativity develop early in life (throughout the first year) and promote successful adaptation. Here I will elaborate on two of these findings from our lab. First, we showed that already 11-month old infants associated the conform behaviors of others with social approval, but non-conform behaviors with social disapproval, as indicated by their pupillary surprise response to inconsistent social responses (Figure 1). Such an early and implicit understanding of social norms may be essential for developing infants to make sense of the social world. Second, in a sample from southwestern Uganda, with high levels of maternal adverse experience, we found that unpredictable maternal behavior was related to maladaptive pattern of emotional reactivity (Figure 2). This supports the idea that a predictable social environment is essential for infants early social development. In sum, I will suggest that predictive processes are at the essence of what makes us humans cultural and normative beings and drive human socio-cognitive development from early in life, to reduce entropy in complex human lifeworlds.

Abstract 3: The Role of Prediction and Top-Down Modulation in Perceptual Development: Neural and Behavioral Evidence

Perceptual development has largely been considered as either a bottom-up, experience-driven process or one where maturational constraints, such as biologically-determined critical periods, determine the pathways of perceptual development. This talk will consider whether infants are able to change their perception based on predictions that engage top-down mechanisms and whether this mechanism could add another route by which experience can shape perceptual development. First, a series of studies has investigated the perceptual impacts of prediction using behavioural measures. Xiao and Emberson (2023) report that an auditory cue can result in changes in motion perception at 6-7 months of age. This study shows that newly learned audiovisual associations can be used by infants to shift their perception flexibly and rapidly in just a few minutes of exposure. Xiao and Emberson (2019) developed a new method to determine perception of emotional faces on single trials using eye-tracking and found that infants at 10 months showed better perception of emotional faces when they were preceded with an emotional vocal sound (e.g., crying before a sad face). In both of these studies, the ability to predict upcoming sensory input allows an infant to improve their perception. This improvement is present even when the predictions are based on stimuli from another perceptual modality (e.g., auditory cues predicting visual stimuli) and when the contingencies are learned in just a few minutes of exposure and when infants are as young as 6 months of age. Overall, these studies suggest that infants are able to use predictions to change their perception very early in life. The talk will then go on to examine how predictions are related

to a well-established phenomenon in perceptual development: the other-race effect. Using a different face perception paradigm (temporal processing of faces), Xiao et al. (under review) investigated the impact of prediction on face perception of own (white) and other-race (East Asian) faces in infants raised in a mono-racial white community in North America. While the required learning for the task was identical across own and other-race faces, infants were only able to use prediction to augment their perception of own-race faces with no effect of prediction on other-race faces. This finding suggests that prediction and top-down modulation vary along with other aspect of experience and may exhibit specialization that can shift perceptual capacities along with other aspects of perceptual development. Finally, the talk will present key neural findings linking prediction to activity in the frontal cortex. Jaffe-Dax et al (2020) used the parameters from a well-established computational learning model (Rescorla-Wagner model) to regress against neural activity in prefrontal, visual/occipital and auditory/temporal regions. This analysis reveals that the infant prefrontal cortex is tracking complex patterns in the environment such as prediction error, consistent with previous studies. However, the analysis also reveals that this complex information tracked in the prefrontal cortex is communicated back to the visual system in young infants in contexts where infants can learn and predict. Overall, these findings suggest that top-down processes are a potentially powerful method by which experience can shape perceptual development and where higher-level cognitive systems can influence the development of lower-level ones.

Abstract 4: Prediction error and attention in the developing brain

Prediction has been proposed as a fundamental principle of perception. Generative models reflecting our knowledge and expectations about the environment in higher-level cortical areas are thought to send predictions down to lower sensory levels in a hierarchically organized system. On the sensory level predictions and sensory input are compared. If there is a mismatch, the prediction error is propagated up the hierarchy to update the models. Generative models are postulated to be established through learning and experience, so predictions and prediction error play a central role in early development. However, we still know relatively little about how the underlying mechanisms develop at the brain level. Violation of expectation (or prediction error) can trigger attention and surprise as described in recent models of involuntary attention. The interaction between prediction error and attention and surprise appears to be a key factor in learning processes. We used pupillometry to investigate the allocation of attention and surprise to motivationally relevant and personally significant unexpected events in 14- to 36-month-olds. Results show that both unexpected emotional sounds and personally significant sounds evoke a stronger attention and surprise response than unexpected emotionally neutral or personally non-significant sounds. Similar to these studies, the presentation of an unexpected stimulus or action instead of an expected stimulus or action has frequently been used in infancy research. However, these paradigms confound prediction error to presentation of unexpected input with prediction error to omission of expected input. To minimize this confounding influence of bottom-up inputs, input can be omitted to isolate the prediction error to omission of expected input. This allows the analysis of brain responses that can only be explained by prediction. To reliably study sensory omission responses in the brain, the omission must be temporally linked to an event, such as an auditory event to a visual event, or to an action. Recent concepts propose that sensory and motor information are integrated in a common prediction system. Because of the importance of actions and action consequences in development, we have used action-effect coupling to study prediction processes. An action that is reliably coupled to a sensory consequence carries sensory predictions down to the level of sensory cortices. We coupled an action to auditory stimuli to investigate the specificity of sensory predictions in early childhood. Early specific and unspecific omission responses in the EEG, generated in the auditory cortex, presumably directly reflect prediction error. Results indicate a matured flexible generation of specific, higher-weighted

predictions and unspecific, lower-weighted predictions. This is remarkable because brain responses to auditory stimuli, that are generated in the auditory cortex, are not matured until late childhood. This approach also demonstrates that brain omission responses are a useful strategy to directly study the development of prediction. In sum, the presented studies at the intersection of perception, action, and attention illustrate the flexibility and relative early maturity of prediction mechanisms in the developing brain. Omission paradigms address an important theoretical perspective and can be a promising approach for developmental research.

S.21 Differing Perspectives of Group-Related Sensitivity

Linda Harrison [1], **Belinda Friezer** [2], **Wilfried Datler** [3], **Katharina Ereky-Stevens** [4], **Robyn Dolby** [5]

[1] Macquarie University, [2] Charles Sturt University, [3] University of Vienna, [4] University of Oxford, [5] Secure Beginnings

Summary

Group-related sensitivity, (Ahnert et al., 2006) is more strongly associated with attachment security in child care settings, than one-on-one positive caregiving. The symposium authors explore differing perspectives of group-related sensitivity and show how this influences infants' development and experiences of closeness. Paper 1 reports on two Viennese studies: (1) mixed-method, and (2) qualitative, of children's transition to childcare. They show caregivers' group-related sensitivity predicting all toddlers' attachment security. Paper 2 describes an Australian intervention for managing childcare morning transitions. Educators' group-related sensitivity kept the group members close and able to observe each other's relationships.Paper 3 presents an Australian childcare longitudinal study. Video-recordings of infant interactions in peer groups, and educators' perceptions of them, identified infants' developing capacity for a group-related sensitivity.

Details

Abstract 1 Title: Young children's experiences of interactions in group contexts during the transition to centre-based childcare. The role of one-to-one involvement with adult caregivers versus observed interactions of adults and other children in the the group

Introduction: Research on early child development rarely builds on models of relationships that take account of children's complex networks of relationships with adults and peers in groups. Building on attachment theory, the expectation would be that as young children settle into childcare, their direct involvement with adult caregivers who respond sensitively to their signals would determine their developing attachment relationships. Yet, it has been found across several studies, that what caregivers do with *all* children in group care is more predicative for young children's developing secure-base expectations.

Aim: Building on our research findings on the importance of group dynamics (Ereky-Stevens et al., 2018), we present observation materials to exemplify how, by observing interactions of others in group settings, young children adapt their behaviour, develop their relationships, and take forward their learning. We discuss implications such findings can have for the practice and training of educators in early years settings.

Study Population: This presentation builds on information collected as part of two studies on children's transition to group childcare: (1) a mixed-method study that investigated relationship building between 104 toddlers (aged 10-33 months) and their new caregivers in 71 Viennese childcare centres, and carried out in-depth observations with 12 children, (2) an in-depth qualitative study that focussed on the impact of rules and rituals on transition processes of four 3-4-year-old children.

Methods: (1) Data for 104 children was collected across three time points within toddler's first four months in childcare. This included attachment security (Attachment Q sort; Waters, 1995), video-recorded observations of toddlers' interactions with caregivers (coded with a focus on dyadic sensitivity), and live observations of group-related caregiver sensitivity (captured through the Caregiver Interaction Scale; Arnett, 1989). (2) 12 of the 104 toddlers were also weekly observed, using the psychoanalytic Tavistock Observation Method, (3) which was also used in the study about the impact of rules and rituals on transition processes, with added interviews with caregivers and parents.

Results: The findings of the Vienna study "Toddlers' transition from home to out-of-home care" show that dyadic sensitivity does not predict toddlers' attachment security. Caregivers' sensitivity in interactions with all children, however, predict toddlers' attachment security. Combining these findings with the analysis of the observations draws attention to the fact that children perceive the sensitivity of caregivers' interactions not only with the children themselves, but also with other children. This has an impact on the development of the inner working models, which are decisive for the children's attachment behaviour.

These considerations suggest that, in relation to the development of secure attachment, a greater distinction should be made between the significance of the quality of dyadic interactions between caregivers and the target child; interactions between caregivers and groups to which the target child belongs; and interactions between caregivers and other children observed by the target child.

Abstract 2 Title: Educators' group-related sensitivity builds close relationships during morning goodbye transitions in centre-based child care settings

Introduction: The morning goodbye transition has generally been understood in terms of dyadic relationships, i.e., parent-infant, educator-parent, or infant-educator. However, this transition typically involves three or more participants; the educator, infant, parent and onlookers. Research into professional development programmes that supports educators to attend to the needs of individual infants, whilst also managing the group during the morning goodbye is needed. It will help to understand how educators' developing capacity for group-related sensitivity can build close relationships during times of stress and distress.

Aim: This research examines how the professional development programme, Baby Playspace Learning (BPL), was associated with more triangular interactions (measures of closeness) in the Negotiated Goodbye.

Study Population: Participants were 20 families and their infants aged between 8 and 18-months who were enrolled in an Australian Long Day Care centre. Of the 20 infants, nine were girls. Participants also included five educators who worked in the infants' room of the centre.

Methods: In a pre-post design, video recordings of 20 morning goodbye transitions (10 pre and 10 post) were collected across a 12-month period. Infants, their parents and educators were filmed when the infant and parent entered the room and ended when the parent left. A reliable observational coding system was developed to code the video recordings of the morning goodbye transitions. Video recordings were analysed for developing closeness, by measuring the frequency of triangular interactions.

Results: Post-test educators engaged in significantly more triangular interactions, keeping the 'team of three' physically and emotionally close. Infants observed their parent and educator in relationship as they engaged in a 'negotiation goodbye ceremony'. Educators created more openings for parent and infant to come together in a mutual meeting or expression of affection, so that the goodbye was not left out and the educator was able to observe the closeness between them. After the infant and parent separated, the educator maintained this closeness by asking the parent to wave at the door, turning the infant toward their parent and reassuring them within their parent's hearing that their parent was thinking of them. In this instance, the parent was able to observe the closeness between the educator and infant. Post-test, onlooking infants were significantly more likely to watch/and or listen to the goodbyes of their peers. This moment of connection helped them understand their own and others' experience and see that adults could manage such difficult moments.

To conclude, BPL was effective in supporting educators to stay in close to infants, families and infant peers during the morning goodbye transition. Post implementation of BPL, educators developed a capacity for group-related sensitivity where they could attend to the needs of an individual infant while also managing the group by creating opportunities for each of them to witness the developing closeness in relationships during this potential time of distress. Educators became part of a group based on shared experiences rather than just managing competing individual demands.

Abstract 3 Title: Infants' sociality and developing capacity for group-related sensitivity amongst peers in centre-based child care.

Introduction: In centre-based child care, many similar aged infant peers are in the company of each other for long periods of time. Yet, little is known about infants' sociality within their peer groups, and their developing capacity for a group-related sensitivity. We define infant group-related sensitivity as a developing awareness of: (1) the relationships between their peers, and (2) their capacity to influence the relationships between their peers.

Aim: This research brings together key concepts of infant social development, dynamic systems theory, and educators' perceptions in a mixed-methods design to identify the social developmental pathway of infant' group-related sensitivity and the motivation that underlie this pathway.

Study Population: Participants were 45 infants from two Australian child care centres who were observed across the first two years of life. Of the 45 infants, 20 were focus infants aged between 3 to 21-months (9 female; 12 male). Participants also included four educators who worked with and knew the infants well.

Methods: Micro-analytic and psychoanalytic observation research methods were applied. The 20 focus infants were filmed as the third infant in a triad (defined as a third infant and an interacting infant-peer dyad) every 2- to 3-months across a 12-month period. A reliable observational coding system was

developed to identify interactions in triads and code infant behaviours and behavioural sequences with their peers. A data set of 564 episodes was generated, coded and analysed using quantitative methods. In addition, each infant's educators were interviewed while viewing video extracts of infant triads, generating 18 interviews that were transcribed and analysed using structural and thematic approaches.

Results: Analyses of coded videos showed that infants demonstrated a broad pattern of relating with peers that involved watching, approaching and engaging their interacting peers. Results indicate that the behaviours occurring within this broad pattern of relating are not yet set. According to dynamic systems theory, this findings suggest that infants are in a state of instability as they learn how to engage with members of a group. In terms of infant social development, infants engaging in this repeated pattern of relating are developing group-related sensitivity in peer groups. in this form of group-related sensitivity infants are developing: (1) a sensitivity to the interactions between their peers, and (2) an awareness of their capacity to influence the behaviour of their interacting peers.

Insights from educator interviews identified third infants' motivation for engaging with peer groups as: being curious and interested in their peers, working out the interactions between the dyad and seeking belonging and togetherness.

To conclude, infant-peer groups are dynamic linking systems consisting of specific moment-to-moment group processes that: (1) develop infants' capacity for group-related sensitivity; (2) form the basis for longer term social developmental change in infants, and (3) serve to meet infants' underlying desire for belonging in groups.

S.22 Complementary approaches to investigate genetic contributions to infant psychologically-relevant traits

Anna Gui [1], **Angelica Ronald** [2], **Aislinn Bowler** [3], **Anja Hollowell** [3], **Ana Maria Portugal** [4]

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Summary

Despite twin research indicating heritability of early milestones, skills and behaviours, minimal gene discovery work has been conducted at scale. Here we showcase new results obtained using complementary methods, that together reveal the role of genetic influences on infant traits.

The first talk exploits the classic twin design to reveal the relative contribution of genetic, shared environmental, and nonshared environmental factors in infant visual attention. The second talk explores the longitudinal genetic architecture of infant temperament. The third talk employs polygenic scores to test for associations between preschool fine motor skills and neurodevelopmental and psychiatric conditions. The fourth talk demonstrates that individual differences in age at onset of walking are influenced by common genetic variants involved in infant brain development.

The discussant will consider how these new genetic results can be applied widely in developmental psychology research.

Details

Abstract 1 Fixation durations during abstract versus naturalistic scene viewing have dissociable genetic influences at 5-months.

Visual attention is a key factor in infants' interaction with their surrounding world. Attention selection of inputs for learning can be triggered by bottom-up low-level perceptual saliency (e.g. movement, color) and top-down high-level relevant content (e.g. task-relevant information, social preferences, and familiarity). The dichotomy between bottom-up and top-down stimulus selection is fundamental to attention research. In the first months of life, eye movements are thought to be predominantly triggered in a bottom-up way; and top-down control seems limited. Around 3 to 6 months, top-down control is thought to gradually explain more of infants' viewing behaviour. Yet, the development and interplay of these processes remains largely unknown.

Here, we report on the genetic and environmental influences on spontaneous eye movement patterns during free viewing of naturalistic scenes, and the extent to which eye movements reflecting bottom-up or top-down processes are under the same or dissociable etiological influences.

We analysed the duration of fixations from 536 dizygotic and monozygotic 5-month-old twins, part of the BabyTwins Study Sweden (Falck-Ytter et al., 2021), in two experimental viewing conditions (Urabain et al., 2017). In one we showed naturalistic scenes of dynamic social meaningful stimuli (three people playing with objects), where top-down factors are important determinants of gaze allocation; in the other condition, we showed abstract scenes, which were digitally scrambled versions of the naturalistic condition, thus identical in terms of low-level features but lacking semantic meaning, and where gaze is predominantly under influence of bottom-up factors. Six videos were presented for about 20 seconds each and gaze was recorded with a Tobii TX300 eye-tracker. The R package Gazepath (Renswoude et al., 2018) was used for fixation estimation. We expected to find significant genetic influences to eye movements, and predicted that genetic factors, although would be partly shared between the two conditions, would also uniquely explain the variability in the naturalistic scenes (see preregistered analysis plan: https://doi.org/10.17605/OSF.IO/5Q27B).

Mean fixation duration in naturalistic (Mean = 553, SD = 116, n = 521) were shorter than in abstract scenes (Mean = 603, SD = 150, n = 520); $p < .001$). We observed significant genetic influences in both conditions (heritability in naturalistic condition = .30, 95% CI [.14, .44]; heritability in abstract = .25, 95% CI [.09, .39]). We did not find evidence for significant shared environmental influences, which is in line with other twin studies of gaze metrics. We found that most of the variation in fixation durations was explained by non-shared environment, which could be accounted by measurement error, but also idiosyncratic factors within individuals and stimuli.

Importantly, we showed that some genetic influences were shared between the two conditions, but as hypothesised, unique genetic factors were linked to naturalistic scene viewing only. This means that dissociable genetic factors explained eye movement control during observation of naturalistic meaningful scenes versus abstract non-meaningful stimuli with identical low-level properties, suggesting that top-down and bottom-up processing, which are thought to differ in terms of function, development, and brain basis, are under control of dissociable genetic factors at 5 months.

Abstract 2 Genome-wide association studies of infant temperament

We will present work from the Genetics of Early Milestones and Skills (GEMS) project, which aims to investigate the common genetic architecture of psychologically relevant phenotypes in infancy using Genome-wide Association studies (GWAS). Specifically, results from investigations of the genetic architecture of infant temperament will be discussed. A recent meta-analysis of twin studies reported significant pooled heritability of these traits; the present research builds on this knowledge by identifying specific common genetic variants associated with these complex traits.

We employed the Buss & Plomin (1977) 'EAS' model to study infant temperament, focussing on their constructs of Emotionality, Activity, Shyness and Sociability at ages 2 and 3 years. We also studied infant fussiness in the first year of life.

We hypothesised that infant temperament traits between 0-36 months will show significant Single Nucleotide Polymorphism (SNP) heritability (h^2_{SNP}) and that common genetic variants will be significantly associated with individual differences in infant temperament traits.

The GEMS project employed data from community samples and population-based cohorts with genotype data for infants assessed between 0-36 months. The largest of these cohorts was the Norwegian Mother, Father and Child cohort study (MoBa, N~55,000). Other samples included bring the total meta-GWAS sample size to 72-83,000 depending on the phenotype.

GCTA fastGWA was used for the association analysis, using a genetic relatedness matrix to account for relatedness within each sample. Covariates included age at data collection/year of birth, sex and 10 ancestry principal components, as well as any relevant technical variables (e.g. genotyping batch). A genome-wide significance threshold of $p=5x10^{-8}$ was used to correct for multiple testing.

Temperament was measured using parent-report questionnaires. Different studies measured temperament at different ages; as such, the meta-analysis data were conducted in age 'bins' for year 1 (6-12 months), year 2 (13-27 months) and year 3 (28-40 months). In the largest sample, MoBa, Emotionality, Activity, Shyness and Sociability were measured at ages 2 and 3 using the EAS temperament questionnaire, and Fussiness was measured at age 1 using the Infant Characteristics Questionnaire (ICQ-6) fussy/difficult subscale. In other cohorts, if different temperament measures were employed, where possible a comparable subscale or matched items were used. GWAS results from individual samples were then meta-analysed.

From analyses to date in MoBa (the largest sample), infant temperament traits from the EAS model showed significant but modest h^2_{SNP} estimates above 1%. Infant fussiness in the first year of life showed higher SNP heritability of 10.2% (SE=0.92). Manhattan plots and genome-wide significance thresholds have been interrogated, and significant loci identified. Analyses are ongoing for some of the smaller individual studies; complete results of the meta-GWAS will be described in the talk.

We see convincing evidence for modest but significant role of common genetic variation on infant temperament traits from ages 0-36 months after birth. Future research will include exploring genetic associations between infant temperament and later outcomes, and assessing how genes interact with early environments longitudinally across the infancy life stage.

Abstract 3 Phenotypic and genetic associations between preschool fine motor skills and later neurodevelopment, psychopathology, and educational achievement

Fine motor skills are heritable and comprise important milestones during the preschool years. However, it is unclear if there are genetic or phenotypic associations between early fine motor skills and later neurodevelopmental, psychiatric, and educational outcomes.

In a pre-registered study of 9625 preschool children from the Twins Early Development Study, fine motor assessments (drawing, block building, folding, and questionnaires) were conducted at 2-, 3-, or 4-years as part of a cognitive assessment delivered by parents. A cross-age fine motor score was derived using principal component analysis. Multivariate regression was conducted between the fine motor score and neurodevelopmental traits, psychopathology, and educational outcomes at three later ages (7/8-, 12-, 16-years) and cross-age psychopathology composite scores.

We hypothesised that there would be negative associations between fine motor skills and later neurodevelopmental and psychiatric traits, and positive associations between fine motor skills and later educational achievement at age 16 years. Next, polygenic scores (PGS) were created for neurodevelopmental, psychiatric, and educational outcomes (namely, ADHD, autism, anxiety, major depressive disorder, obsessive-compulsive disorder, schizophrenia, and years in education). We ran single-PGS models with permutation-corrected p-values and a multi-PGS model with elastic-net regularised regression to account for multicollinearity.

As predicted, fine motor skills were negatively associated with neurodevelopmental traits and psychopathology across childhood and adolescence, including traits for ADHD, autism, anxiety and depression, behavioural problems, and some specific psychotic experiences (See Figure 1). Also as predicted, fine motor skills were positively associated with educational achievement in adolescence (ß=0.25, p<0.001). In the single PGS analysis, as hypothesised and consistent with the phenotypic analysis, superior fine motor skills associated with a higher years in education PGS (ß=0.07, p<0.001) and a lower ADHD PGS (ß= -0.04, p=0.011, See Figure 1). However, superior fine motor skills were associated with a higher anxiety PGS (ß= 0.03, p=0.040), which was not hypothesised. Similarly, the multi-PGS model retained the PGSs for years in education (ß=0.07), ADHD (ß= -0.03), and anxiety (ß= 0.01). A non-pre-registered analysis was conducted in an independent preschool sample (N= 202) enriched for family history of autism or ADHD (The British Autism Study of Infant Siblings and the Studying Autism and ADHD in the Early Years) that had assessed the children on a standardised motor assessment (Mullen Scales of Early Learning).

These analyses replicated the finding of higher ADHD PGS associated with lower fine motor abilities at age 24-months. The associations of gross motor abilities with the years in education and anxiety PGS did not replicate in this second independent sample. Fine motor skills in the early years appear to be linked genetically and phenotypically to later neurodevelopment, psychopathology, and educational outcomes. Further work should investigate the mechanisms underlying the role of fine motor development in later outcomes.

Abstract 4 Genome-wide association meta-analysis of age at onset of walking

Onset of walking is a gross motor milestone which shows wide individual differences: it can be achieved within a relatively wide developmental period, typically between 8 and 18 months old. Individual variability in this trait has often been attributed to environmental factors by research, although there is evidence that genetic factors also play a role. For example, a large twin study reported a twin heritability of age at onset of walking of 84%. Further, the ADHD polygenic score was associated with it. However,

no studies to date investigated the DNA variants contributing to individual differences in this motor milestone.

We hypothesised that genetic variants associated with this trait are involved in biological pathways influencing brain areas implicated in motor control.

A total of 70,560 infants (34,918 females) were included in this study from four European-ancestry cohorts: Lifelines[1] (N=3,415), the Norwegian Mother, Father and Child Cohort Study[2] (MoBa, N=58,302), National Study of Health and Development[3] (NSHD, N=2,592) and the Netherlands Twin Register[4] (NTR, N=6,251).

We conducted a GWAS meta-analysis of age at onset of walking. The analyses were pre-registered (osf.io/m2qv3). Age at first independent steps in months was obtained from retrospective parent report when children were aged 18 months (MoBa), 2 years (NSHD and NTR) and 7-to-10 years (Lifelines). Individuals whose age at onset of walking was below 6 months or above 36 months were excluded. GCTA fastGWA and PLINK 1.9 were used for association analyses in all four cohorts. Summary statistics were meta-analysed in METAL. Coloc.SuSiE was used to identify genetic variants associated with age at onset of walking that influence gene expression in the brain. LD score regression was used to calculate common variants-based heritability, bivariate genetic correlations and to test whether heritability was enriched in specific cell types. A leave-one-out design was employed to test prediction of the age at onset of walking polygenic score (PGS), calculated via PRS-cs. PGS was associated with regional brain volumes in T2-weighted Magnetic Resonance Imaging data acquired at term equivalent age from the independent Developing Human Connectome Project[5] cohort.

We identified multiple independent loci in the DNA that are associated with this milestone (Figure 1). Follow-up investigations showed that one of these genetic variants was associated with decreased gene expression in the human cortex. We found that 23.2% (SE=1.2%) of the individual differences in our key phenotype were explained by common genetic variants. The variants associated with later onset of walking were genetically correlated with lower likelihood of ADHD, lower BMI and higher intelligence, educational attainment and adult brain folding and gyrification. The age at onset of walking PGS was associated with regional neonatal brain volume in areas involved in motor skills across the lifespan including the basal ganglia, thalami and cerebellum.

The results provided candidate causal genes for this heritable phenotype, and implicated genes expressed in the cerebellum and cortex. Extending this investigation to a more diverse population would be important to produce robust findings on the biology underlying the onset of walking.

S.23 Lactocrine Programming: Optimizing Infant Outcomes Through Understanding Human Milk

Brittany Howell [1], **Rebecca Powell** [2], **Ellen Demerath** [3] **Nina Bruinhof** [1], **Hellen Lustermans** [4], **Anna Ziomkiewicz** [5], **Martijn Finken** [6]

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Details

Abstract 1 Title: Milk Matters: Inter-individual variation in human milk composition predicts infant growth and adiposity changes in the first 6 months

Background
Recent scoping reviews have highlighted the lack of large rigorously designed studies of the relationship of human milk components to infant growth rate and metabolic status.
Objective
Our objective was to assess the association of individual variation in macronutrient, human milk oligosaccharide (HMO), and metabolite concentrations in mature human milk with variation in term infant growth and adiposity in the first six months of life.
Methods
Data and biospecimens are from the Mothers and Infants LinKed for Health Growth (MILk) Study, a prospective United States observational cohort of 348 exclusively breastfeeding women and their singleton, term, appropriate for gestational age infants. Maternal health and demographic information was collected from medical records and via questionnaire. Infant weight and length z-scores were calculated from data collected at 1, 3, and 6-month postpartum study visits. Infant body composition at 1 and 3 months was assessed using air displacement plethysmography (ADP) and at 6 months using dual energy x-ray absorptiometry (DXA). A single full breast expression was obtained according to a standardized protocol and was gently mixed, aliquoted, and stored at
-80◦C. Milk macronutrient concentrations were assayed using the Miris Human Milk Analyzer, HMOs were analyzed by HPLC after adding an internal standard and labeling with a fluorescent tag 2-aminobzamide, and milk metabolite abundances were measured using untargeted liquid chromatography-gas chromatography-mass spectrometry. Multiple regression models tested associations of each set of milk component concentrations with infant growth and body composition. Models were adjusted for covariates and potential confounders such as maternal age, income, and education level and infant age and sex. All p-values were adjusted for false discovery rate (FDR) using the Benjamini–Hochberg procedure ($q<0.05$ considered significant).
Results
Milk true protein concentration was positively associated with infant weight-for-length change from 1 to 6 months and inversely associated with infant adiposity at 1 month. Milk carbohydrate concentration was inversely associated with infant length gain from 1 to 6 months and positively associated with infant adiposity at 1 month. In regard to HMO concentration, higher levels of 6-sialylactose (6'-SL) was associated with more rapid weight gain from 0-6 months ($p=0.004$), which was associated with faster fat-free mass ($p=0.002$), but not fat mass gains. Out of 458 milk metabolites detected, there were 6 differentially regulated metabolites tied to fatty acid oxidation, brain and neurodevelopment, and steroid synthesis that were associated with rapid infant weight gain (i.e. an increase >0.67 Z score from 1-6 months of age), including upregulated deoxyinosine, and downregulated suberic acid, pregnanolone sulfate, pregnenolone sulfate, nonanedioate, and DHEA sulfate.
Conclusions
In this large U.S. research cohort of exclusively breastfeeding dyads, a variety of milk compositional factors at 1 month predicted differential growth and body composition over the first 6 months of life. Identifying milk predictors of infant growth trajectories will inform future precision approaches to supporting positive infant developmental outcomes.

Abstract 2 Title: Breast Milk as a Potential Medium for Trauma Transmission from Mother to Infant

Introduction. Maternal childhood traumatic events can affect the physical and psychological development of offspring through mechanisms of intergenerational transmission that involve both germline-dependent and independent pathways. Milk composition plays a vital role in mother-infant communication about environmental challenges, and it can have a programming effect on infant metabolism and behavior. Our recent research suggests that milk-derived microRNAs (miRNAs) carried with lipid-associated factors may transmit information about maternal trauma and its effects through generations.
Hypothesis. In this study, we investigated the impact of maternal childhood traumatic experiences on milk fatty acid profiles, milk-derived miRNA expression, infant growth, and temperament development in mother-infant dyads from a healthy general population of Southwestern Poland. We hypothesized that mothers with high childhood trauma (HCT) will produce milk with altered composition of fatty acids profile and different expression of selected miRNA when compared to mothers with low childhood trauma (LCT). We also hypothesized that changes in milk composition of HCT and LCT mothers will reflect in differences in physical and temperamental development of their infants.
Methods. We collected information about the number of childhood traumatic events from 104 mothers of healthy, born-on-time, and exclusively breastfed infants using the Early Life Stress Questionnaire (ELSQ). We collected milk samples at 5 months and took infant anthropometric measurements and temperamental assessments at 5 and 12 months. We assayed the samples using gas chromatography to assess the level of medium-chain (MCFA) and long-chain (LCFA) (unsaturated and saturated) fatty acids. We also performed small RNA sequencing followed by q-PCR to assess the expression of milk-derived miRNAs.
Results and conclusions. Our findings show that HCT mothers had a higher level of MCFA ($F_{1,94}=6.81$, $p=0.01$) and upregulated expression of 3 miRNAs (miR-142-5p, 142-3p, 223-3p) in their milk compared to those with LCT. Furthermore, HCT was linked to higher infant weight ($F_{1,94} = 8.06$, $p = 0.006$; $F_{1,89} = 7.17$, $p = 0.009$) and head circumference ($F_{1,94}= 6.17$, $p = 0.01$; $F_{1,89} = 5.06$, $p = 0.027$) at 5 and 12 months. Levels of MCFA and miRNAs that differed between LCT and HCT mothers were also associated with infant temperamental traits of falling reactivity, activity, distress to limitations and soothability at the same time points. Overall, our research sheds light on the potential role of milk composition and milk-derived miRNAs in the intergenerational transmission of the effects of maternal childhood trauma.

Abstract 3 Title: Maternal stress and milk cortisol concentrations

Introduction. Human milk is a highly complex liquid food, with long-term health benefits for both mother and infant. Growing evidence suggests that non-nutrient bioactive factors in human milk may contribute to the (long-term) development of behavior and cognition, a process termed lactocrine programming. Milk glucocorticoids have been of particular interest, as they have been associated with infant outcomes such as temperament, cognition and social behavior. Previous research points at reported maternal stress being one of the potential determinants of MC. However, other studies did not find evidence for an association between reported maternal stress and MC. These conflicting findings could be the result of methodologic heterogeneity between studies. For example, intervals between assessment of maternal stress and MC differed between studies, ranging from a few hours to six weeks, while both maternal stress and maternal cortisol secretion fluctuate over time. Therefore, we carried out two studies to examine more direct links between maternal stress and MC concentrations. In Study 1 we investigated moment-to-moment associations of maternal reported stress and concentrations of MC. In Study 2, we examined causal relations between a laboratory stressor and post-stressor concentrations of MC.
Hypotheses. Study 1. We hypothesize that higher levels of reported stress are associated with higher MC

Back to top

concentrations, when they are assessed at the same moment. Study 2. We hypothesize that: 1) An acute laboratory stressor will increase MC concentrations compared to MC concentrations of mothers in a control group, 2) Postpartum mental health problems (PMHP) will moderate the effect of the acute stressor, with mothers high in PMHP showing a stronger increase in MC concentrations post-stressor. Method. Participants were mothers from a healthy, community sample. For Study 1, at six weeks postpartum, mothers (n=110) collected three milk samples on one day (morning, afternoon and evening) and simultaneously reported on their stress levels using visual analogue scales. For Study 2, mothers (n=80) were invited for a lab visit around eight weeks postpartum. During the visit, mothers were divided into two groups and either exposed to the Trier Social Stress Test or a control task. Around twenty minutes post-stressor, mothers collected a milk sample to analyze cortisol concentrations. Prior to the visit, PMHP (i.e. stress, depression and anxiety complaints) were measured using online self-report surveys.
Results and conclusion. The data has all been collected and currently, analyses are being carried out. Results will be presented at the conference. The results of this study will contribute to the knowledge on potential influences of maternal stress, as a modifiable maternal factor, on MC concentrations. This knowledge might aid the development of future interventions optimizing the lactation process.

Abstract 4 Title: Moment-to-Moment Associations Between Breast Milk Glucocorticoids and Infant Crying and Sleep

Introduction. Breast milk composition has been found to fluctuate in relation to maternal and infant factors. These changes in composition may affect infant development. For example, cortisol in mother milk has been associated with infant negative affect. However, evidence supporting the role of breast milk glucocorticoids (i.e., cortisol and cortisone) on infant behavior is inconsistent, potentially due to methodological heterogeneity and daily fluctuations in both milk cortisol and infant behavior. Furthermore, infant behavior might also affect breast milk glucocorticoids, however, this has not yet been studied. To address these issues, the current preregistered study investigated bidirectional associations between diurnal breast milk glucocorticoids and infant crying and sleep. We hypothesize that 1) higher milk glucocorticoid concentrations will be related to more infant crying and less infant sleep, and 2) more infant crying and less infant sleep will be related to higher milk glucocorticoid concentrations.
Methods. At 6 weeks postpartum, healthy mothers (N=109) collected three breast milk samples: in the morning, afternoon, and evening. During this same day, mothers kept a logbook on infant crying and sleep. We calculated the duration of crying and sleeping in three time intervals: 1) the whole interval between each breast milk sample, 2) the 1.5 hours after each breast milk sample, and 3) the 1.5 hours before each breast milk sample. Next, we will perform cross-lagged panel modeling to assess the bidirectional associations between breast milk glucocorticoids and infant crying and sleep. The current study and analyses were preregistered on the Open Science Framework (https://doi.org/10.17605/OSF.IO/9NSRB).
Results. The data collection has finalized and we are now commencing statistical analyses. Results will be presented at the conference. This study is the first to assess moment-to-moment associations between breast milk glucocorticoids and infant behavior. By taking into account the bidirectionality of these associations, the study may increase our knowledge on lactational programming phenomena.

Abstract 5 Title: Comparative analysis of the human milk antibody response to natural infection versus vaccination and assessment of extracted milk secretory IgA as a targeted therapeutic

Background
Secretory Immunoglobulin A (sIgA) comprises ~90% of total immunoglobulin (Ig) in human milk and is critical for milk's protective effects. The secretory chain that envelops sIgA renders it highly resistant to degradation in all harsh mucosal environments such as the milk itself and the infant mouth and gastrointestinal tract, and therefore determining if sIgA is elicited in milk after infection or vaccination is critical. As well, milk-derived sIgA therapy has great potential in the context of various mucosal infections, or as a broad therapeutic in the case of IgA deficiencies. Objectives
Our work aims to study the immune response in milk to infection and vaccination, and in particular the functionality of milk sIgA to protect human milk-fed infants and beyond this, as a potential therapeutic for all.
Methods and Results
Milk was expressed by consented participants in the USA at home under an approved IRB protocol. Antibody titers were measured by ELISA or Luminex assays. IgA was purified by an optimized ammonium sulfate precipitation followed by affinity purification.
After SARS-CoV-2 (COVID-19) infection, robust sIgA was found to be elicited and exceptionally long-lasting throughout the period of lactation, with >90% of the samples exhibiting positive titers and 50% exhibiting less than a 2-fold reduction of specific IgA over 12 months (in the absence of re-infection or vaccination). In contrast, our comparative assessment of the milk Ab response elicited by mRNA and Adenovirus (Ad)-based COVID-19 vaccines revealed mRNA vaccines elicited a potent IgG response that was >10x higher than those measured for Ad vaccines. Ad vaccines elicited specific milk IgG in only ~1/3 of recipients. Moderate milk IgA was measured in ~70% of mRNA vaccine recipients and ~20% of Ad vaccine recipients, with the sIgA response being low and uncommon for all groups. These responses were short-lived, with all classes waning significantly by 3m, and sIgA undetectable by 6m. Notably, our Influenza vaccine studies have also shown that seasonal influenza vaccines induce a poor milk antibody response and virtually no boosting of seasonally-specific milk sIgA.
As a test of milk sIgA function we extracted IgA from pooled milk obtained from our SARS-CoV-2-infected cohort. COVID+ or COVID-naïve milk IgA was administered to mice intranasally (IN) and intratracheally (IT) 24h before IN inoculation with SARS-CoV-2. IgA was administered 2h after inoculation and each day for 2 days. Viral titers were measured in lungs 72h post inoculation. Mice receiving 0.25mg/day or 1mg/day of COVID+ IgA exhibited significantly reduced virus titers in lungs compared to control.
Conclusions
Currently-licensed vaccines do not elicit significant milk sIgA. There is a true need to design vaccines with the lactating population and their infants in mind, to develop pre-clinical models towards this goal, and to include lactating people in vaccine research. As well, our in-vivo work supports further development of milk-derived sIgA therapeutics.

Abstract 6 Title: Breast-milk glucocorticoids and infant development

The secretion of glucocorticoids is a classic endocrine response to stress. However, perturbations in hypothalamus-pituitary-adrenal (HPA) axis activity have been linked to cardiometabolic disease and major depression. Vertical transmission of glucocorticoids via breast milk might pose a mechanism through which lactating women could prepare their infants for the postnatal environment. Our group showed that milk glucocorticoid concentrations increase with the duration of pregnancy, and follow the diurnal rhythm of maternal HPA axis activity. Animal experiments and observations in man suggest that milk glucocorticoids could exert their effects in newborns direct or indirectly (e.g., through alteration of

the microbiome), locally (i.e., in the gut) or systemically (i.e., after intestinal absorption). This might have repercussions for vulnerable groups, such as preterm infants and infants born to mothers with psychological distress.

Abstract 7 Title: Human milk exosomes impact white matter development: A preliminary, complementary in vivo and in vitro study

Background
Infants are dependent on milk as their sole source of nutrition for the first ex utero months of life, a time of unparalleled brain development. It is during this time that the cells that will mature to enrobe axons forming the brain's white matter (oligodendrocyte precursor cells, OPCs) are migrating and proliferating. Infants fed formula have been demonstrated to show alterations in brain white matter, suggesting that something in milk contributes the maturation of these key brain cells. One potential milk component that could influence white matter development is microRNA (miRNA), protected in extracellular vesicles.
Objectives
The objectives of this study were to, 1) assess the impact of miRNAs sequenced from isolated EVs on infant white matter, and 2) determine if treatment of cultured OPCs with milk EVs impacted cellular proliferation and ability to produce myelin.
Methods
Pregnant people (n=6) were recruited and consented prenatally to participate in the study. All infants were delivered full term, and experienced uncomplicated deliveries. Structural and diffusion MRI were collected during non-sedated natural sleep at 2 weeks and 3 months in each infant. EVs were isolated from whole milk samples collected immediately before bed time (to control for any impact of circadian and/or diurnal rhythms) at three time points during the first three postpartum months – 1-3 days, 7-10 days, and 3 months postpartum to capture changes across colostrum, transitional, and mature milk. RNA sequencing (RNAseq) was completed on RNA from a subset of the EVs, and targeted quantitative PCR was applied to confirm RNASeq results. OPCs were cultured from postnatal day 2 piglets, an ideal model for understanding the impacts of early nutrition on brain development, according to established protocols. Cultures were treated with isolated EVs and allowed to grow for 72 hours. Fluorescence microscopy was applied to confirm the EVs entered the cultured OPCs.
Results
The miRNA content in EVs shifted across lactation, with several miRNAs previously associated with OPC maturation, including Let-7 and miR-17. EVs were shown to enter the nuclei of the OPCs in culture, and OPC cultures treated with EVs showed increased rates of proliferation following 24 hours of incubation with the EVs. Ongoing analyses will relate the miRNAs from these specific samples to development (change across the first three months of life) of white matter integrity, through neurite orientation dispersion and density imaging (NODDI) and total and regional white matter volume across the brain.
Conclusions
Our preliminary results suggest that miRNAs found in milk EVs impact white matter development through influencing proliferation and maturation of OPCs. Ongoing analyses will highlight the impacts of specific miRNAs, providing information required to optimize human milk alternatives with the explicit purpose of providing the best start for all babies through well-supported brain development.

S.24 Comparing the Forms, Functions, and Benefits of Different Modes of Infant-Directed Communication

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Summary

Caregivers intuitively use infant-directed (ID) communicative rhythms (e.g., speech, singing) as tools to actively engage with their infants. What makes ID communication salient, and how do infants process and engage with it? This symposium will present cohesive evidence showcasing how different ID communicative rhythms are structured to guide processes from basic perceptual levels to reciprocal social interactions. It will converge results from diverse infant data focussing on ID speech and singing, including controlled playback experiments (talks 1 & 3), multilingual corpus analyses (talk 2), and naturalistic infant-caregiver interactions (talk 4). The results of the presented studies will be discussed in light of novel theoretical and methodological considerations in early communicative development. This symposium will highlight the forms and functions of different ID communication styles across diverse contexts and how they benefit early development in complementary ways.

Details

Abstract 1, Musical experience is linked with infants' pupillary entrainment to speech:

Early auditory experience with language and music has the potential to shape infants' perception of spoken language. However, only few studies have looked at how exposure to various linguistic and musical activities at home shape infants' speech perception abilities during the first months of life. One possible aspect of language where early experience with language and music may be relevant is entrainment: infants ability to synchronize (electro-)physiological responses to temporal regularities in auditory signals, an ability linked with speech and music perception in infancy (Attaheri et al., 2022, Ortiz-Barajas et al., 2023; Marimon et al. 2022). The present study investigated whether infants' pupillary entrainment with rhythmic speech is associated with their exposure to infant-directed language and/or musical activities at home.

The study used pre-existing pupil size data (Langus et al. 2023) from 6-month-old German-learning infants (N=31) who were tested on their ability to categorize speech rhythm patterns as trochaic (strong-weak) or iambic (weak-strong). This data included parental questionnaire information about infant-directed language and music activities at home: infants' daily exposure to instrumental music, singing, nursery rhymes, and reading, and parental ratings of how musical they were and how melodically they talked to their infants.

In the experiment, infants listened to short trials (N=99) consisting of four instances of the nonword 'gaba', with the first three instances providing the context varying across trials (i.e., within category, across category, and standard context) and the fourth instance providing the test (trochaic or iambic) that was identical across trials. The items were chosen from a lexical stress continuum that co-varied pitch, duration and intensity cues ranging from trochaic to iambic.

We measured how changes in pupil size at word frequency synchronized to the onset of the 4 nonwords in the trial, by calculating the mean phase of the pupillary response at word onset. The data on music and language at home was used in a principal component analysis that revealed strong connections between music-related information (parents' musicality, singing, nursery rhymes) on the one hand, and

language-related (infant-directed speech, book reading) on the other hand, resulting in two separate principal components. Subsequently, we modeled the phase coherence as a function of both the language and music scores.

Results showed that over the trial, at the group level, infants entrained to word onsets when perceiving the 3rd and 4th gaba. Additionally, infants who were more entrained with the onset of the 2nd gaba also reacted more strongly to „between" trial switches on 4th position. Lastly, infants with high scores on music, but not infants with high scores on language entrained better to the word onsets. The results suggest that entrainment is linked with music experience, and with the ability to perceive the difference between trochees and iambs. Since prosody is important for bootstrapping into lexical and syntax acquisition, the present study suggests that experience with music during the first months of life may benefit early prosody acquisition by enhancing infants ability to predictively encode temporal regularities in the speech signal.

Abstract 2, Temporal patterns in the complexity of child-directed song lyrics reflect their functions:

When caregivers present content to a young audience, we structure that content, whether implicitly or explicitly, to optimise its learnability. Previous research has examined how temporally fine-grained changes in prosodic features might maximise the learnability of child-directed speech. However, no previous research has examined larger-scale changes in how information is structured over time in child-directed content.

Our analyses examine the trade-off between two factors: the predictability of new information content, and expressivity – i.e., whether the content yields substantial information gain (reduction of uncertainty) for a particular learner in a particular environment. These two needs, which are fundamental and antagonist, are essential to enable learners to reduce their uncertainty by creating models of their environment in order to make future predictions (Clark, 2013; Köster et al., 2020; Peters et al., 2017). The balance between these two opposite forces, often referred to as the Goldilocks zone, has also been shown to govern infants' allocation of their attention to visual and auditory stimuli (Kidd et al., 2012; Kidd et al., 2014; Poli et al., 2020). Importantly, we posit that this expressivity-predictability trade-off is not an absolute constant universal value but is modulated across features and time depending on the function, intention, context, and agents' prior representations and past experiences.

Here, we developed a novel technique based on Kolmogorov complexity to quantify the rate of change of textual information content over time (see Fig. 1) across different corpora of 453 English-language open-access recordings of songs and stories. We compared child-directed songs, adult-directed songs, and child-directed stories, along with comparison corpora in French (206) and Spanish (263).

First, we show that adult-directed songs show the expected inverted-U relationship between complexity and popularity (indexed as the normalised number of YouTube views). For child-directed songs, in contrast, overall textual complexity is lower and lower complexity associates with higher popularity ($p < .001$). Second, we found that more novel information is presented at the beginnings and ends of songs in child-directed songs compared to adult-directed songs in relation to their sizes ($p < .001$), which can provide benefits in terms of memory encoding because of the Serial Position Effect. Third, we found that, whereas information was evenly allocated in child-directed stories, both child-directed songs and

adult-directed songs showed a periodic oscillatory pattern in the rate of change of information content ($p < .001$), and that those oscillations were more predictable in child-directed songs ($p < .001$).

Our findings suggest that the optimal balance between predictability and expressivity in information content differs between child- and adult-directed content in a way that is compatible with the idea that child-directed songs are structured, whether implicitly or explicitly, by caregivers and young audience, to support a variety of early life needs, like maximise learnability and foster social bonding.

Abstract 3, Musical Priming Influences Infant Language Perception:

Research supports the idea that rhythm in language is reflected in the rhythm of the music written by speakers of the language (Patel & Daniele, 2003). Moreover, it has been proposed that various non-linguistic aspects of culture, like music, may help infants distinguish between languages and draw attention to the culturally relevant properties of their native language. For the bilingual-learning infant, it has been proposed that these distinct aspects of culture that often co-occur with either of their native languages may be used as cues to "activate" that language-mode of processing, thus, culture may function as a binder for language acquisition by helping bilingual-learning infants to separate their languages. (Kandhadai et al., 2014). If there is overlap between the rhythms of the language and music of a culture, and culture can influence linguistic perception, then priming through music could theoretically impact language acquisition. The present study aims to experimentally test the relation between the music and language of a culture by probing whether brief exposure to infant-directed music of the native vs a non-native culture influences phonetic discrimination at an age when perceptual narrowing has begun.

We primed n = 64 ten-month-old infants from English monolingual households and n = 64 infants from Chinese-English bilingual households [ongoing] with a video recording of either a Chinese or English children's folk song sung by an ethnically Chinese or ethnically European/White female singer respectively. We then tested the infants on their discrimination of either the English-specific speech contrast /fa/-/va/ or the Chinese-specific speech contrast /tsa/-/tsha/ using a preferential-looking paradigm. We assessed the looking time difference between alternating and non-alternating trials and found that only for English monolingual infants who had received the English prime and not the Chinese prime were able to discriminate the English-specific speech contrast. In contrast, English monolingual infants who had received the Chinese prime and not the English prime spent more time looking at the non-alternating trials compared to the alternating trials. The preliminary data for 34 Chinese-English bilingual infants suggests that when primed with a Chinese song, infants are able to discriminate both the English-specific speech contrast as well as the Chinese-specific speech contrast but unable to do so when primed with an English song.

These results suggest that culture can indeed influence phonetic discrimination and that culturally relevant cues – here, an audiovisual cue containing the music, language, and face of a singer – are still able to modulate monolingual infants' sensitivity to language even if the process of perceptual narrowing has already begun: In this case, a prime from an unfamiliar culture hindered the discrimination of a speech contrast from their own culture. However, preliminary results from the Chinese-English bilingual infants suggest that in some cases an incongruent pairing of the culture of the prime and the culture of the speech contrast (Chinese prime – English speech contrast) does not hinder the discrimination of a speech contrast from one of their own cultures.

Abstract 4, The Reciprocal Relationship between Maternal Infant-directed Singing and Infant Behaviour:

Caregivers universally and routinely sing to their infants (Mehr & Krasnow, 2017). This type of infant-directed (ID) singing is beneficial for both caregivers and infants by promoting caregiver well-being and social bonding (Fancourt & Perkins, 2017), as well as infant attention and emotion regulation, even more so than ID speech (Tsang et al., 2017). From a structural and functional perspective, ID singing has been divided into lullabies and playsongs (Trainor, 1996). Lullabies are sung to calm and put infants to sleep, while playsongs are used to animate for play, or gain and direct infant attention (Trehub, 2018). These different functionalities have been ascribed to the acoustic structure of playsongs and lullabies. Most notably, playsongs are usually sung faster, higher and more variable in pitch, and louder than lullabies (Cirelli et al., 2020). While previous studies have investigated the acoustic qualities of ID singing and infant reactions to it separately, there might be a reciprocal relationship between fine-grained acoustic changes in maternal singing and infant attention. In fact, infants pay more attention to the beat of ID singing (Lense et al., 2022). However, it remains unclear whether caregivers also adjust to infant attention, e.g., by modulating the acoustic qualities of their ID communication. Changes in amplitude and frequency can be quantified via spectral flux (Mueller, 2015), which is more salient neurally than other musical features (Weineck et al., 2022) and, therefore, might be suitable to quantify the adjustment of mothers' ID singing to their infants' behaviour. Thus, our study explored the contingency of fine-grained acoustic variability of live maternal singing alongside infants' attention to their caregivers. We posit a reciprocal relationship between caregiver ID input and infant attention: Spectral flux should increase around infant gaze onset to indicate that infants are anticipating caregiver input and that caregivers are responding to infant attention.

Seventy-three German-speaking mothers were asked to sing a playsong and a lullaby to their 7-month-old infants while we recorded infant attention via social gaze. We time-locked the beat-normalised spectral flux of maternal singing using the local tempo 3 beats before and after the onsets of infant social gaze.
Our results showed that, overall, spectral flux was higher in the playsong than in the lullaby condition ($p = .019$). Cluster-based permutation tests (1000 permutations) showed that in playsongs, spectral flux was significantly above-threshold around 2.5 beats before look onset and around 1.0 and 2.0 beats after look onset ($p < .0167$; see Fig. 2). There were no significant changes in spectral flux in lullabies.

These findings suggest that infants and caregivers mutually adjust to each other in the context of ID communication and that this mutual adjustment is modulated by song type. Infants react to changes in maternal singing by shifting their attention, and caregivers scaffold salient events after infant social gaze to maintain engagement with the infant. The communicative character of this musical turn-taking may thus be vital for the effects of ID songs as well as an important developmental step towards verbal communication.

S.25 Beyond top-down and bottom-up: how young children dynamically and adaptively influence salience in real-world settings.

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Summary

Traditional approaches emphasise that attention transitions from bottom-up 'attention capture' (automatic, elicited by salient features of the outside world) through to top-down 'attention control' (we choose where we pay attention, and when).

Here we present contrasting talks from three world-leading experts that challenge this perspective. The talks each use different, state-of-the-art new methods. They provide provocative conclusions that force the listener to reconsider this approach to understanding attention development. The symposium will be concluded with a discussion by a world-leading authority on infant attention.

Together, these talks suggest that salience is not just a property of the outside world. Rather, infants and caregivers, both individually and in tandem, adaptively create salience biases in order to influence early attention. This symposium will fundamentally challenge how we think about top-down vs bottom-up influences on attention development.

Details

Abstract 1: Using manual actions to create visual saliency: a sensorimotor mechanism to visual attention

Infants are active learners: they explore and learn about the world by acting on it. Among the many ways that infants' manual actions impact early learning, one critical path is hand-eye coordination – simultaneously holding and looking at an object. The present study proposes and tests a sensorimotor mechanism for hand-eye coordination in which manual actions create visual saliency of handled objects in an egocentric view, and visual saliency, in turn, attracts visual attention (Fig. 1).

Method. To provide a rigorous test of the entire pathway from manual action, to visual saliency in view and to visual attention, we analyzed multimodal behavioral data collected from 36 sessions of parent-infant toy play (M_sessiontim=6.32 minutes, M_age= 19.23 months). Gaze data were recorded from head-mounted eye trackers worn by both infants and their parents (274,539 frames of infants' gaze data and 282,857 of parents' gaze data in total). Manual actions on objects were annotated frame by frame when the hands from either social partner made contact with toy objects. We also used a pre-trained deep learning model (YOLOv3) to detect individual objects in the infant's egocentric view automatically. The visual sizes of objects in the egocentric view were used to measure the visual saliency of those objects.

Results. We identified manual action events by infants and calculated the mean size of the held object in each event, and then used a median split on object size to divide action events into two groups: 1) with a larger size (therefore more visual salient in view) and 2) with a smaller size (less visual salient in view). A comparison of infant visual attention in the two event groups shows (Fig. 2A) that when a manual action on an object created more visual saliency of that object, the infant attended to the salient object much more often than the held object that was less salient (M_salient=0.641; M_no_salienct=0.281; beta=2.086, SE=0.115, p<0.0001). We next conducted the same analysis on parent manual actions and found similar effects of parent actions on visual saliency and visual attention (Fig. 2B). Further, we conducted a head-to-head comparison of the effects of infant and parent actions (Fig. 2C). Even though the infant-held objects were larger in view and, therefore,

more visually salient than the parent-held objects, parent actions are as effective as infant actions in attracting infant attention.
(M_salient_parent_action=0.463; M_salient_infant_action=0.538;beta=0.026,SE=0.030, p=0.263). When a held object became more salient in an egocentric view, either through an infant's or parent's manual action, the infant attended longer to the held object relative to a held object with less visual saliency.

In summary, both infants' and parents' actions in joint play create visual saliency in infants' egocentric view that supports infant visual attention. The results here provide new empirical evidence on dependencies among manual action, visual saliency, and visual attention in everyday parent-child social interactions. The results underscore the reciprocal influences between manual actions and visual attention within the infant's perception-action system and between the parent's action and the infant's attention.

Abstract 2: Dyadic Route to Development of Selective Attention

Traditionally, our ability to selectively pay attention to things has been characterized as a neural filtration process – information 'happens' outside and we passively filter this information to make sense of the world (e.g., Treisman 1969). Contemporary embodied approaches, however, consider that selective attention occurs through our active interactions (e.g., Hommel et al., 2001). In fact, young children actively hold objects of interest close to them, creating selective, clear (Pereira, Smith, & Yu, 2014; Yoshida & Smith, 2008) and highly salient object viewing (Sun & Yoshida, 2021), and when parents name the object, it increases sustained attention to the object (Yu & Smith, 2017) and succession in the learning about the object (Yu, Suanda, & Smith, 2019; Gogate, Bolzani, & Betancourt, 2006). However, the current dichotomy leaves out a critical pathway – how do we get there? In the proposed symposium, I will present data supportive of an alternative solution – social scaffolding (Phillips, et al., 2023; Burling & Yoshida, 2019). Before infants show proactive engagement with objects, parents actively hold objects close to the young infant in a way that makes them highly selective, salient, and neurally meaningful.

I will present a set of recent and ongoing studies from our lab – each study used a portion of observation data from infant-parent dyads participating in an interactive object play with head-mounted eye tracking that captured an infant's and parent's gaze and perspective on play. Some portion of data are longitudinal or synchronized with high-resolution EEG recording that captures infants' momentary neural engagement during the play. The key results regarding the parental impact on early visual experiences include: (1) a semi longitudinal study with 18 parents and their 5- to 24-month-old infants indicates that (a) objects are fixated and captured clearly in the infant's view before infants actively engage the play – as early as 5 months (ΔLOO = 20.1, 95%CI [51.3, 130.1]) and (b) scaffolding may support the infant's sustained attention on objects early as the level of parents' active involvement change as a function of infant's age (ΔLOO = 7.1, 95%CI [29.6, 58.1]). (2) a study with 43 parents and their infants aged from 6- to 18-month-old infants indicates that (a) parents' object holding generates highly salient values around viewed objects ($p < .01$, Figure 1A-C), and the relevance of parents' naming of infant attended object to the "top-down" attention that is guided by verbal cues in a preferential-looking paradigm ($\beta = -2.92$, $p < .01$). (3) a cross-sectional study with 30 parents and their 6 months and 12 months infants with the combined system examining the neural correspondences associated with sustained attention indicates that when infants' attention is accompanied by parent object handling, there was an enhanced power change (6-10 Hz) occurring around the onset of infant's sustained

attention (Figure 2).

The line of studies is our first step to understand how foundation of our ability to pay attention to things is nurtured socially – providing a new framework for explaining the role of parental scaffolding on early learning and development.

Abstract 3: Caregivers dynamically and adaptively alter their salience, moment-by-moment, contingent on the child's attention state

Introduction: What are the mechanisms through which joint attention is achieved? Classic approaches emphasise joint attention as a one-way flow of information from an adult caregiver, who didactically structures infant attention using ostensive cues, to an infant, who is passively sensitive to the adult's ostensive signalling (Csibra & Gergely, 2009). But an overwhelming body of evidence now suggests that, in fact, children are remarkably insensitive to adults' ostensive signalling during shared interaction (Southgate & Begus, 2019; Wu & Gros-Louis, 2015; Yu & Smith, 2012). For example, they do not follow caregiver gaze (Yu & Smith, 2012), and they show little to no neural responsivity to caregiver gaze behaviours (Marriott Haresign et al., 2022).

So how, exactly, do infants and caregivers influence one another during shared interaction? Here, we investigate the hypothesis that caregivers influence infant attention by dynamically and adaptively altering the salience of their own behaviours, moment-by-moment, contingent on the attention state of the child.

Methods: We recorded free-flowing dyadic play across a tabletop with toys between N=66 infants of mean (sd) age 11.18 (1.27) months (33 female) and their caregivers (see Figure 1). During the play we recorded infants' brain activity with EEG, and videoed infant and caregiver behaviours with high resolution (50fps) cameras, and recorded infant and caregiver vocalisations with a microphone. We hand-coded infant attention shifts at 50Hz, and analysed cortical theta activity as a fast-moving measure of infant attention engagement (Perapoch Amado et al., 2023). We analysed multiple features of the caregiver's behaviour, including: their own attention shifts; the rate of change of the fundamental frequency of their voice (F0) (thought to be a marker of auditory salience (Huang & Elhilali, 2017)); the rate of change of their facial features (using Face Alignment, an open-source facial feature classifier); the rate of chance of their hand positions and limbs (using OpenPose). We also computed semantic complexity by compressing in to index the amount of novel information over time, based on Kolmogorov complexity (Chater & Vitányi, 2003; Wolff, 2014), and computing the derivative of that time series to obtain an instantaneous information rate, here referred to as semantic complexity.

We then used cross-correlation analyses to examine how caregivers dynamically adapt their own salience (rate of change of voice, face and physical movements), as well as the complexity of their own object-directed talk, relative to fluctuations in infant attention. Surrogate cross-correlations were created by assigning theta timeseries to other speech streams, and significance was tested by performing a cluster-based analysis with 500 permutations with a final threshold of alpha = 0.05 (Meyer et al., 2021).

Results and Conclusion: Our analyses suggest that, during shared interaction, caregivers dynamically recalibrate their own behaviours, moment-by-moment, contingent on the attention state of the child (bootstrapping ps<.01). For example, caregivers dynamically adapt their own attention behaviours (Fig2a), dynamically modulate the complexity of their own object-related speech (Fig 2b), and their own

vocal salience (rate of change of F0) (Fig 2c), second-by-second, contingent on infant attention engagement.

S.26 The mechanisms of early vocabulary growth: Insights from vocabulary network analyses

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Summary

Our proposed symposium presents a network analysis approach to early vocabulary growth from perspectives of word learning, word production, and language perception. Our central research question considers: What mechanisms drive early vocabulary growth? Our methodology draws from parental report data and naturalistic home recordings across three distinct languages to explore individual longitudinal semantic networks, phonological networks, and effects of child-directed speech on vocabulary acquisition. Across our three studies, we find that the early lexicon is driven by internal mechanisms: already-learned words attract new words for acquisition with similar sound and meaning. The results, however, show differences in regards to the influence of the words in the child's environment. This symposium offers an exploration of the interplay between phonological and semantic factors as well as child-directed speech in shaping the developmental trajectory of early vocabulary acquisition.

Details

Abstract 1 Exploring systematicity in the developing lexicon with phonological networks

Infants' early words are phonologically similar (Vihman, 2016). Deuchar and Quay (2000) show that 13/20 of a bilingual (English-Spanish) child's first words are produced with a CV structure, and many are identical: car, clock, casa 'house' and cat are produced as /ka/, and papa 'daddy', pájaro 'bird' and panda as /pa/. Infants may produce newly-acquired words in a systematic way, drawing on what they already know in development to further advance their phonological/lexical knowledge and articulatory skills. This may help them deal with the combined challenges of memory, planning and articulation in early phonological development. That is, systematicity may be a crucial mechanism in early word learning.

Network analysis can account for systematicity in early phonological acquisition, whereby similarity between forms determines their connectivity within a network. If early phonological development is indeed led by systematic production, as the above example suggests, then we would expect the early vocabulary to contain many similar-sounding forms. This would be manifested in a phonological network as tight clusters of similar-sounding forms. This hypothesis can be tested via two established models of network growth: preferential attachment (PAT; an internally-driven network where new words resemble the most well-connected forms in the existing network) and preferential acquisition (PAQ; an externally-driven network where acquisition reflects the connectivity of the target language, in this case the input, Hills et al., 2009). Previous studies have tested connectivity between target forms (i.e. adult target productions) of vocabulary norm data, with mixed results (Fourtassi et al., 2020; Siew & Vitevitch, 2020). In this study, I draw on naturalistic data to test infants' actual productions of early words, to identify whether developing phonological networks are driven by PAT- or PAQ-like growth. I propose that PAT offers a more plausible model for phonological development, given that infants tend to adapt early

words to fit established production routines (Vihman, 2019), and thus new words are likely to resemble existing words in the network.

I analyze early phonological networks (constituting >1.6 million unique connections) from 9 infants (4 males; Demuth et al., 2006; Demuth & Tremblay, 2008) between 0;11 to 2;6. Phonological distance between each word and each other word in each child's data was computed to establish networks of infant productions using Euclidean distance (see Monaghan et al., 2010), to generate network growth values that represent PAT- and PAQ-like network growth (see Siew & Vitevitch, 2020 for full outline of network growth values). Results show that infants draw on what they already know in early production: logistic regression models with word learning in the following month as a dependent variable (was the word learned: yes or no) showed that PAT growth values, but not PAQ, predicted whether or not a word was learnt in the following month ($\chi2(2)=11.29$, $p<.01$) when frequency in the input and word length in phonemes were controlled for. There was no interaction with age ($p>.5$), suggesting that this is not only an effect of very early learning, but is retained across the first two years of word production.

Abstract 2 The influence and interplay of sound and meaning in the development of early vocabulary networks

While much work has emphasised the role of children's environment in language learning, research equally reports consistent effects of their knowledge, i.e., the words known to individual children, in steering further lexical development. Thus far, findings have predominantly focussed on the semantic similarity between words in the child's environment or lexicon to the word to be learned. While recent work has extended this to the phonological similarity between words in the child's environment/lexicon to the yet-to-be-learned word, thus far, no research has compared the role of phonological and semantic similarity on word learning. However, since the form and the meaning of a word are both irrevocably associated with the words, it is important to investigate the relative contribution of form and meaning overlap to word learning. Furthermore, much of the literature is based on cross-sectional data, assuming that the words typically known to children at n months predict the words typically known to children at n+x months. Given the variability in the number of words known to individual children at different ages, a more conclusive analysis of this issue requires examination of individual differences in the words learned by individual children across development, i.e., using longitudinal data.

In the current study, we examine the influence of similarity in sound and meaning on word learning using longitudinal vocabulary data from Norwegian children (n=215, #observations >5). We ask whether the phonological and semantic connectivity of a not-yet-learned word to words that the child already knows, or words in the child's environment predicts the likelihood of the child learning that word. Furthermore, we investigate how the interplay of phonological and semantic connectivity influences word acquisition. We represent each child's growing vocabulary as increasing networks and fit multiple logistic regression models to gain insights into different contributing factors.

The results suggest that the early vocabulary grows predominantly in a rich-get-richer manner, where word learning is predicted by the phonological or semantic connectivity of a word to words already known to the child. However, word learning is, albeit to a lesser extent, also influenced by the phonological and semantic connectivity of a word to words in the child's linguistic environment. Both effects are greater for younger than for older children. In general, semantic connectivity plays a more prominent role in word acquisition than phonological connectivity, which means that similarity in meaning leverages word learning more strongly than similarity in sound. Critically, we find that a yet-to-

be-learned word is easier to learn when it connects to words in the lexicon which are highly connected themselves in only meaning, as compared to words which are highly connected in both form and meaning. In other words, children find it more challenging to learn words which are connected in both domains, possibly due to greater overall similarity which makes them harder to differentiate from each other. Our results highlight the promise of using longitudinal data to better understand the factors that influence vocabulary development and the insights to be gained from analysing different contributing factors concurrently instead of separately.

Abstract 3 Community structure in the phono-lexical network of child-directed speech

The mental lexicon can be represented as a network of word forms, with pairs of nodes (or vertices) joined by lines (or edges). The study of networked phonological word forms has become an increasingly important facet of psycholinguistic investigations of speech processing, involving speech recognition, retrieval, lexical learning, and speech errors (Beckage & Colunga, 2016; Vitevitch, 2021).

Networks of phonological word forms are found to naturally divide into modules or communities. Those are densely connected groups in which all words are more similar to one another than they are to nodes outside the group. Phonological networks of adult language speakers have demonstrated good community separation (Siew, 2013, Siew et al., 2023), with community sizes related to lexical characteristics of words. A proposal has been made that larger communities develop first in language acquisition, as they may be a precursor for developing a robust language network in first-language learners (Siew, 2013). Since the lexicon of child-directed speech is adapted to facilitate learning in the listeners (Huttenlocher et al., 1991), the child-directed phonological network may be organized in a way that reflects an emphasis on certain community structures.

The present study investigated the phonological network of child directed speech (or 'CDS') in order to see whether it preferentially exposes children to larger network communities. CDS data were obtained from the Nuffield Corpus of 76 British mothers speaking to their 11-month-old infants (McGillion et al., 2017). A comparative adult-directed phonological network was constructed with data from the British National Corpus (or 'BNC'). Phonological neighborhoods within the two lexica were identified by computing the Levenshtein distance between word forms. The Louvain method of community detection was employed.

Results show that the CDS network differs from the BNC network in various important ways. The CDS network not only contains a much larger number of phonological communities in the densely interconnected giant component part of the network, but community sizes were also larger (see Table 1).

In the CDS network, words of higher lexical frequency, shorter length, and denser neighborhoods tended to reside in the largest communities. The opposite trend could be seen in the BNC network. These findings have implications for lexical activation spreading in the CDS network: high-frequency, short words with denser neighborhoods being grouped together in large communities implies that a large portion of the lexical activation primarily occurs in this particular region of the CDS lexicon, where words are frequently activated and retrieved and compete with one another. In addition, phonologically similar words tend to belong to the same communities and this allows predictions about the phonological properties of words that children tend to learn first. Similar word forms may be acquired at the same time in order to form the foundation of a new community within the infant phonological network. The

findings of this study indicate that caregivers restructure their phonological lexicon when addressing infants, with potential implications for infant lexical learning.

S.27 The impact of infant sleep on current and future outcomes: Perspectives from typical and atypical populations

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Summary

Infancy is marked by change in many domains, including sleep. Such changes span sleep macrostructure (e.g., duration & timing) and microstructure (e.g., EEG features), both of which are linked to long-term cognitive and health outcomes. Most prior literature includes measures of only sleep macrostructure and focused on typical populations. Our symposium will describe recent research filling both gaps. Two presentations focus on sleep in the context of prematurity. Both include sleep EEG features and relate this to sensorimotor development and later neurodevelopmental outcomes. The next extends the discussion of EEG features to typical toddlers and the refinement of gross motor behaviors. The final presentation adds long term outcomes, studying infant sleep, later ASD diagnoses, and behavior at school age. Subsequent discussion will focus on (1) balancing methodological considerations and participant burden and (2) applications for early intervention or future research directions.

Details

Abstract 1: The effects of prematurity on sleep and brain development.

We sleep the most when we are young, yet premature birth leads to an early increase in the amount of time an infant spends awake due to the abrupt change in the developmental environment as well as the infant's own health status and need for care (Bennet et al 2018; Knoop et al 2021). Since the third trimester of gestation is a period of rapid brain growth, it is unknown if this dramatic change in behavioral state organization impacts neural development. New evidence is showing, however, that it may indeed be the case. Specifically, the amount of sleep – in particular, active (or REM) sleep – has been shown to correlate with white matter tract development in premature infants at term age (Wang et al, in press). Furthermore, previous work in non-human and human neonates, has shown that spontaneous brain activity, in the form of spindle bursts, predominates during sleep but not wake in the early perinatal period (Dooley et al 2020; Whitehead et al 2018). Spindle bursts not only show state-dependent activity but are also reliably elicited in response to the spontaneous myoclonic twitches (Dooley et al 2020) that are a hallmark of active sleep. Altogether, this strongly suggests that sleep and twitching should be protected in premature infants to promote brain development.

In our current study we aimed to see whether sleep and twitching in the neonatal intensive care unit (NICU) and the commensurate neural activity, can be used to better understand and/or predict risk for atypical development. To do this, we are acquiring video and EEG data from 1- to 2-hour sleep sessions at the University of Iowa Stead Family and Children's Hospital NICU, from both extremely (<32 weeks gestational age) and mildly (>32 to <37 weeks gestational age) premature infants.

For 11 extremely premature infants and 10 mildly premature infants, sleep was staged from both video, scored by observers, blind to group, and using physiological measures (e.g., heart rate, respiratory rate, and blood oxygenation). EEG activity and twitching, also scored by observers, will compared between groups for infants at the same gestational age at the time of the session. In this preliminary discovery cohort, we found that from 30 to 33 weeks gestational age, extremely premature infants were awake, on average, more than 30% of the time during the session. This amount of wakefulness persisted at 34-36 weeks gestational age and was also observed in mildly preterm infants at the same gestational age. When asleep, infants exhibited increased EEG activity in the spindle burst range (8-25 Hz) during both active sleep and quiet sleep. Suggesting that a reduction of either active or quiet sleep will impact the amount of spontaneous activity produced by the developing brain. Current analyses are looking at the relationship between the twitches observed during active sleep and production of spindle bursts in somatosensory cortex. Ultimately, the goal of our work is to understand both short- and long-term outcomes when sleep and twitching are disrupted.

Abstract 2: The effect of moderate to late preterm birth on sleep EEG features in early infancy

Introduction: Moderate-to-late premature (MLP) birth occurs between 32 and 36 weeks gestational age (W.H.O., 2023). MLP-born neonates show higher morbidity and mortality than term-born peers and MLP-born children have lower educational outcomes (Celik et al., 2013; Crockett et al., 2022), but their developmental trajectory has received far less attention compared to their more preterm counterparts. Neurophysiological features of sleep have been shown to be biomarkers of underlying brain maturation (Fattinger et al., 2014; Kurth et al., 2012; Sokoloff et al., 2021). We aim to compare EEG sleep features at 4 months of age between MLP-born infants and a control group born at term.

Hypothesis: We predict sleep features in MLP-born infants will show a different developmental trajectory to term-born infants.

Study population: Low risk MLP and term-born infant groups recruited at birth at a local hospital from 2017 to 2018.

Methods: Daytime sleep EEGs were recorded in both groups at 4 months corrected age. Sleep was staged according to AASM criteria, and the analyses were based on the first sleep cycle. Groups were compared for sleep stages duration, latency to sleep and REM. Sleep spindles were identified manually, and groups were compared for spindle density, number, symmetry, synchrony, spectral power, frequency, and duration. Groups were also compared quantitative EEG background features, including: relative and absolute spectral power and connectivity, as measured by inter- and intra-hemispheric coherence. Both cohorts had a Griffiths III assessments at approximately 18 months; general development and subscales quotients were compared between groups.

Results: From the two cohorts, 59 MLP (30/59 females) born at a median (IQR) chronological age of 24.3 (22.9-25.9) weeks and 96 term-born infants (40/96 females) born at 19.4 (18.6-20.4) weeks were included in the sleep study.
MLPs had fewer sleep spindles (MLP: median (IQR) 212.00 (137.50-280.00); term-born: 253.00 (213.00-293.00), p=0.029), and a shorter N2 sleep stage (MLP: 2.75 (1.88-4.63); term-born: 4.50(2.50 to 6.50) minutes, p<0.001]. MLPs also had higher power in delta 1 frequency [MLP: 702.49 (557.46- 840.67)µV2; term-born: 593.34 (449.21-749.36)µV2, p=0.011], and delta 2 [MLP: 245.31 (194.17-327.77)µV2, term-born: 215.32(164.78-283.39)µV2, p=0.028] and lower relative gamma power during NREM [MLP: 0.0016

(0.0013-0.0019)%; term-born: 0.0018 (0.0015-0.0022)%, p=0.034]. Differences in connectivity were also seen, with a general increase of frontal and lower interhemispherical parieto-occipital coherence in the MLP group. The Griffiths lll developmental assessment revealed that general development quotients mean (SD) were 119.45 (10.78) for term infants and 112.12(13.67) for MLPs (p<0.001).

Conclusions: Low risk MLP infants show multiple EEG sleep biomarker alterations in comparison to term born infants, reflecting changes in brain organisation and function which may relate to their lower developmental scores. Future work will correlate sleep features in MLP infants to their neurodevelopmental outcome scores directly.

Abstract 3: The impact of sleep spindles on fine and gross motor development

The second year of life is a period of motor skill refinement. Most major gross motor skills are acquired, but continue to be honed as toddlers learn to flexibly adapt to the constraints of their environment and specific scenarios (Hadders-Algra, 2018). Sleep is relevant to this process through short-term consolidation of procedural memories and, perhaps, more globally supporting the integration of the sensorimotor system (Sokoloff et al, 2021). The mechanisms through which sleep supports motor learning are not fully explained. In examining the EEG during overnight sleep, researchers can document how distinct neural oscillations evolve over developmental time and relate to short- versus long-term outcomes.

One commonly studied EEG feature is sleep spindles, bursts of 10-16 Hz activity which occur during NREM and have been associated with motor skill acquisition. Developmental changes in spindle topography, duration, and frequency slow after the first year of life, but continue through adolescence. By approximately 18 months, spindles can be subdivided into slow (<13.5 Hz, in frontal region) and fast (>13.5 Hz, in central regions) spindles (Kwon et al., 2020). The former have been associated with memory consolidation while the latter are related to more general cognitive performance (Jaramillo et al., 2023).

In this talk, I will present a study aimed at examining how spindle frequency and coherence relate to early motor development. We hypothesized that (1) faster spindle activity and (2) greater spindle coherence, specifically across hemispheres, would be positively related to fine and gross motor development. Fifteen 16-26 month-olds participated in an overnight sleep session and completed the Bayley IV. Sleep was measured via in-lab polysomnography. Within the EEG data, we focused on frontal (F3/F4) and central (C3/C4) channels. Spindles were automatically detected from each channel (Vallat & Walker, 2021). Several records were scored by an expert to confirm the reliability of this method. We calculated median spindle frequency and co-occurring spindle duration during the first two hours of sleep.

Preliminary analyses using Bayesian regressions found median spindle frequency was more influential than age in predicting both fine (Spindle: BF10 = 1.45 vs. Age: BF10 = 1.23) and gross motor (Spindle: BF10 = 1.84 vs. Age: BF10 = 0.46) ability. Contrary to Hypothesis 1, slower spindle activity was related to better motor performance (See Figure 1). Spindle coherence was defined as the proportion of simultaneous spindle activity across two channels out of the total duration of spindle activity. While not associated with fine motor development (all BF10 < 0.7), coherence in the central region was marginally associated with gross motor skills (BF10 = 1.08), providing limited support for Hypothesis 2.

These results enhance our understanding of the mechanism through which sleep supports motor development. Early NREM features, sleep spindles, appear to play a specific role. As such, a promising application is to study sleep spindles in populations with sleep disturbances and/or motor delays. Future work should assess the generalizability of the findings which may improve interventions and long term outcomes.

Abstract 4: Sleep and the Developmental Progression of Autism

Autism Spectrum Disorder is the diagnostic term used for neurodevelopmental disabilities characterized by social communication and interaction difficulties and restricted and repetitive behavior and interests (APA, 2013). Sleep problems affect the majority of autistic individuals (up to 93%; Petruzzelli et al, 2021). Autistic individuals tend to demonstrate the defining features of insomnia; longer sleep onset latency, reduced total sleep time, more night awakenings, and more early morning awakenings compared to neurotypical peers. Insomnia predicts the severity of core diagnostic features of autism and impacts the quality of life of individuals and their caregivers. Furthermore, animal models have shown that sleep disruption during early development can cause autism-like behavioral deficits in adulthood. Nonetheless, the nature and impact of sleep problems in autism during early development remains largely undetermined.

This submission has three aims: 1) present recent findings on sleep alterations and development in young autistic children, 2) describe new data on sleep patterns in a longitudinal cohort of children at higher and lower familial likelihood of autism, and 3) discuss implications for understanding the relationship of sleep problems to developmental trajectories in autistic individuals.

Participants were ascertained through the longitudinal, multisite Infant Brain Imaging Study (IBIS) network based on having an older autistic sibling (higher likelihood; HL) or no family history of autism (lower likelihood; LL). Participants were assessed at 6, 12, and 24 months and at school-age (7-12 years). Infants and caregivers completed a battery of direct assessment and parent-report measures at each age point and diagnostic evaluation at 24-months and school-age. Brain development was assessed with non-sedated MRI at each age point. A subset of the longitudinal cohort also participated in a sleep assessment at school-age where parents completed sleep questionnaires and daily sleep diaries, and children completed 10 days of actigraphy.

Data collection at school-age is ongoing, but preliminary analyses (n=174) reveal an endophenotypic pattern of parent-reported sleep problems, with highest levels in autistic children (HL+), intermediate levels in non-autistic children with an autistic sibling (HL-), and lowest levels in unaffected children with no family history of autism (LL). However, actigraphy revealed unexpected results in which the non-autistic siblings (HL-) demonstrated lower total sleep time than HL+ or LL (See Figure 1). Further analyses will evaluate the relationship of parent-reported sleep concerns and infant temperament at 6, 12, and 24 months of age to sleep outcomes in these three groups at school age.

In a longitudinal, prospectively ascertained cohort, we found that longer sleep onset latency in the first year of life was associated with increased hippocampal volume trajectories and increased likelihood of autism at 24 months (MacDuffie et al., 2021). Analysis of parent-reported and objectively measured sleep patterns in this group at school-age is underway. We will evaluate the relationship of early sleep concerns and temperament to school-age sleep patterns. This evidence, if found, would suggest that

sleep disruption early in life may interact with genetic vulnerability to drive lasting behavioral changes in autism.

S.28 Exploring rhythm processing in early infancy through multi faced lenses: genetics, microbiome, experience, behavior

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Details

Abstract 1: Understanding genetic influences on the brain's capacity to process musical rhythms: a neurodevelopmental-genomic approach

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Rhythm sensitivity emerges very early in child development, beginning during prenatal development, and with mounting evidence that neonates and young infants perceive some aspects of the musical beat. Musical beat perception and synchronization have been theorized to have played an important role in human evolution of developmental social and communication traits, suggesting that genetic signals linked to human rhythm should be linked to neurodevelopment. Our prior Genome-Wide Association Study (GWAS) of beat synchronization in N=606,825 individuals found that the genetic architecture of musical rhythm was enriched for brain-specific regulatory function in fetal neural tissues (Niarchou et al., 2022). In other words, genetic markers associated with individual differences in adult rhythm ability were more likely than chance to play a role in gene regulation of gene expression in fetal neural tissue, thus suggesting that genetic variation helps the brain very early on lay down neural architecture that affects rhythm into adulthood. The current work aims to further investigate the genetic contributions to the brain building blocks of rhythm. First, we examined potential gene signals of rhythm in 67 cell types, derived from the midbrain and prefrontal cortex of embryonic and fetal tissues. Gene property analysis (using MAGMA) revealed that the genetic architecture of rhythm is significantly enriched for GABAergic neural and neuroblast cell-types from midbrain embryonic tissue, along with GABAergic neurons from fetal tissue gestational week 26 ($p<0.0003$, FDR-significant). This enrichment of neural precursor cell-types and neuronal cell-type fetal tissue (particularly at 26 weeks' gestation, a sensitive period of auditory development) points to GABA as an important brain building block of the functional architecture of rhythm sensitivity in very early prenatal development. To further connect the genetic architecture of rhythm to processes of neocortical spatial organization, we curated 42 gene sets from co-expression modules computed from transcriptome profiles of the mid-gestational brain from publicly available BrainSpan data at high spatial resolution. Findings from gene set analyses illustrate that rhythm is enriched in gene sets involved in inner and outer cortical plate development and

transient subplate zone development (p<.01, FDR-significant). Results were robust from additional analyses controlling for general cognition. I will discuss these findings in the context of ongoing research highlighting shared genetic influences between beat synchronization and developmental language-related traits. This study lays groundwork for identifying the neural endophenotypes that may support genetic contributions to rhythm processing in the developing brain, and suggest candidate mechanisms by which genetic variation (DNA variation across individuals) programs the wiring of the brain so that it is primed for rhythm processing, starting during prenatal development. Taken together, the neurogenomic approaches employed here shed new light on biological function and structure linked to rhythm traits during neurodevelopment.

Abstract 2: Neural tracking of rhythm during the third trimester of human gestation and the impact of neural maturation on the neural response to rhythm

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The perception and synchronization to periodicity at various tempos or timescales hold significant developmental importance, as evidenced by studies on language development, music behaviors, bonding, and early social interaction. However, the timing of the emergence and development of neural capacities for coding these temporal hierarchies remains unknown. Auditory perception develops gradually during the last trimester of pregnancy and continues to refine for many years after birth. Although cortical auditory evoked potentials are recorded in premature newborns as young as 28 weeks gestational age (wGA, almost when the auditory cortex is connected to the outside world through thalamic afferents) (Daneshvarfard, 2019), it is it is not yet clear how and when the neural coding of the basic acoustic features gradually evolves into the coding of auditory rhythms similar to observations in adults. The goal of the present study is to clarify how the encoding of the metrical hierarchy, including the basic beat and metrical structure, develops and evolves in the course of the third trimester of gestation. We conducted a cross sectional study of 46 premature neonates, born during the third trimester of gestation between 28 wGA and 36 wGA. During the first week after birth, while in the incubator, we evaluated their neural activity during sleep using 64 to 128-electrode EEG in response to a repeating six-beat auditory rhythmic sequence (Flaten 2022). We compared younger premature neonates born between 27 and 33 wGA and older premature neonates born between 33 and 36 wGA. We found that both age groups showed neural synchronization to the fast periodicity related to the beat, whereas only the older group showed significant neural synchronization to the slower meter frequencies related to neural representation of beat groupings. We also found that neural synchronization to the beat and meter frequencies became gradually stronger with increasing gestational age at birth, and that the oscillatory phase differences between the beat events and neural responses became less variable between participants and converged on smaller phase differences between stimulus and neural responses, similar to those observed in adults (Doelling 2019). Next, we developed a thalamo-cortical neural model to explore the impact of the early evolution of the inhibition-excitation balance (Chini, 2022) on the emergence and enhancement of neural responses to the metrical hierarchy. The modeling results showed that the tilting of the excitation-inhibition ratio toward inhibition (strengthening of inhibition) in the cortical networks leads to the emergence of the meter related responses. This study elucidates the development of the neural tracking of auditory rhythm. It extends the previous neurodevelopmental research on the early neural tracking of rhythm by

demonstrating its maturation during the third trimester of gestation—a developmental phase characterized by the rapid structural and functional evolution of the brain.

Abstract 3: How enriched prenatal rhythmic stimulation affect visuospatial attention and non-nutritive sucking behavior in newborns and 2-month-old infants.

Rhythm -i.e. the repetition of regular temporal patterns that supports the development of expectations- entrains attention and facilitates perceptual performances in adults (Dynamic Attending Theory, Jones et al., 2002). The ontogenetic origins of this phenomenon remain unexplored, and, considering how ubiquitous rhythms are in the infants' perinatal environment, the question is compelling. The human fetus perceives numerous rhythmic cues within the womb through the auditory, vestibular and tactile senses (Lecanuet & Schaal, 2002) and the marked rhythmic structure of perinatal sensory/social experience fosters infants' communicative and cognitive development (Provasi et al., 2014, 2019). On this ground, we explored how contingent rhythmic stimulation influences visual attention disengagement and Non-Nutritive Sucking (NNS) behavior at birth and 2 months, and how prenatal rhythmic enrichment modulates these effects. In Study 1a, thirty 24-72-hr-old newborns and thirty 2-month-old infants were tested in an overlap task where a central stimulus (S1) was followed by a peripheral target (S2) and saccadic reaction times to reach S2 were recorded as measure of attentional disengagement (e.g., Valenza et al., 2015). The temporal attributes of S1 were manipulated to obtain three within-subjects S1 conditions: the baseline condition, in which S1 remained static on the screen, the rhythmic condition, in which S1 flickered at a rhythmic rate, and the non-rhythmic condition, in which S1 flickered at a random rate. The peripheral stimulus was always static and could randomly appear either at the right or the left of S1 after about 3 seconds of looking times towards S1 (i.e. 4 beats in the rhythmic condition) (Figure 1). In Study 2, starting from the 29th week of gestation, two groups of pregnant women followed a rhythmic (G1) or non-rhythmic (G2) enrichment protocol and the visual attentional skills of their infants were tested in the same gap-overlap task used in Study 1 at birth and at 2 months. In Study 3 (N=43, in progress), NNS was measured in newborns assigned to G1 and G2 and in a control group of unstimulated newborns during a silent baseline, and during contingent rhythmic and non-rhythmic acoustic stimulation. Results from Study 1a showed that at 2 months, but not at birth, saccadic latencies were slower in the non-rhythmic condition compared to the other two (mixed-models, $p<.001$) (Figure 2), despite 2-month-olds showed no preference for any of the S1-stimuli when tested in a pairwise preference task (Study 1b). This same effect was present in Study 2 only for the newborns assigned to G1 ($p=1$), who were slower in disengaging attention from the non-rhythmic-S1 compared to the rhythmic S1, just like the unstimulated 2-month-olds. For this group, the amount of stimulation also predicted overall disengagement latency ($p<.001$) (Figure 2). Preliminary results from Study 3 show that NNS is selectively inhibited during non-rhythmic stimulation in the control group ($p=.031$), and this effect is modulated by the amount of prenatal rhythmic enrichment ($ps<.04$). Results suggest that prenatal rhythmic stimulation is capable of enhancing postnatal sensitivity to temporal cues and promoting infants' motor and visuospatial attention abilities.

Abstract 4: The role of the gut microbiome in neural tracking of rhythm and implications for brain development in premature infants

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Perception and action occur over time, and rhythm (i.e., temporal regularity) is a fundamental organizing principle across these domains. The regularity of rhythms enables organization of incoming information in real time, future planning, and reduces computational resources. Language and music structure contain temporal regularity, and the ability to process rhythm is critical for their acquisition. Thus, it is perhaps not surprising that our recent research shows that even the brains of premature infants track rhythmic structure in sound (Edalati, et al., 2023) and that this ability improves from 26 to 32 weeks gestation. Several factors likely affect the development of auditory rhythm perception, including genetically-guided neural maturation and exposure to rhythmic stimuli such as the maternal heart beat and maternal movement. It is also now clear that brain function is influenced by gut microbiota, and there is accumulating evidence that early microbiome interactions along the gut-brain axis may have evolved to promote cognitive functions and behaviors. In a pilot study, we used EEG to measure neural tracking of the beat of an auditory rhythm in infants at 6 months of age, and correlated their individual neural responses to an analysis of their gut microbiome using shotgun metagenomics of fecal samples. While the sample size of this pilot was relatively small, we found positive associations with pathways related to biosynthesis, degradation, assimilation and generation of precursor metabolites and energy production (after FDR correction), including branched chain amino acid biosynthesis and pentose phosphate pathways (Hunter, et al., 2023). Currently, a larger study is underway in a group of premature infants, to be collected over the next 2 years (200 infants born between 26 and 33 weeks gestation). Microbiome samples are collected before discharge from the Neonatal Intensive Care Unit as well as at 2 months corrected age, once infants are in their home environment. Neural rhythm tracking and rhythmic social engagement (using the method of Lense et al, 2022, which measures the extent to which infant eye movements to the face occur at metrically strong beats while watching videos of infant-directed singing) are measured at 6 months corrected age. In addition to demographic and health variables and the Bayley Scales, standardized questionnaires include the MacArthur-Bates Communicative Development Inventory (CDI), Ages & Stages Questionnaire, Music@home questionnaire, Early Microbiome Questionnaire, and parents' Goldsmiths Musical Sophistication Index (G-MSI). Using modeling techniques, we expect to see associations between neural rhythm tracking and the gut-brain pathways identified in the pilot study. This research will extend the findings of our pilot study in elucidating how the gut microbiome relates to rhythm processing in particular, and cognitive functioning in general. It will also contribute to understanding potential effects of probiotic treatments in the case of premature infants.

Abstract 5: Prenatal experience of maternal walking rhythm on head postural control

Temporal regularities (tempos) are omnipresent from the earliest age in the physical and social environment of an infant's life. It is now well documented that fetuses and infants are capable of perceiving and adapting to the rhythms of their physical and social environment (Provasi et al., 2014) and that this skill supports their cognitive and social development (Bobin-Bègue, 2019, 2020). From then on, the question that arises is how this early experience is established. One of the most important and earliest experiences of tempos during development is the maternal walking rhythm, firstly during gestation and then during carrying in the postnatal period. The vestibular system is functional fairly early in gestation (e.g. Lecanuet & Schaal, 2002). In addition, one of the first stages in subsequent development is one that requires reliance on vestibular information in order to stabilise head posture, in particular to enable the development of visuomotor coordination. We therefore put forward the hypothesis that at 2 months, the infant's head support is more effective when the mother, who is carrying the infant, walks at her usual pace rather than at a faster or slower pace, because the infant has more experience of her mother's usual walking pace (we assume that this is also the pace that the infant was most often confronted with during

gestation). One way of verifying this hypothesis is to test whether infants anticipate their muscular control more when they are carried by their mothers walking at a usual pace compared with a faster or slower pace. In this study, 17 mothers carried their infants (mean age 57 days) vertically against them while they walked in a straight line. Using a wireless electromyographic recording device (a method already used in other infant studies, e.g. Addyman et al., 2016), contractions of the sternocleidomastoid muscle (a muscle strongly involved in head stability) were recorded synchronously in the infant and their mother. The recordings were made under 3 conditions, in a counterbalanced order between the participants: a fast, normal or slow walking rhythm (at her discretion). These recordings were supplemented by video recordings to check for the absence of artifacts and to associate the different phases of the experiment. The aim of the analyses is to compare whether the muscle signals from the infant and the mother are closer when the mother walks at her usual pace. The analyses are about to begin. The data will be pre-processed using the "eda_clean" function in the neurokit2 package (Makowski et al., 2021). The results of this study, if they confirm the hypothesis, would support the more general hypothesis that tempo, in addition to supporting the development of motor and socio-cognitive skills, would support continuity between mother and child through temporal characteristics (echoed by rocking and singing in parenting practices). The results of this study will therefore be used to support a larger-scale research project on the question of a vestibular temporal basis, in the form of tempo, for the establishment of an early relationship between mother and infant.

Abstract 6: The role of neural entrainment to visual rhythms in the development of selective attention: a longitudinal study

Research with adults suggests that the ability to selectively attend to relevant rhythmic stimulus streams in one's environment is achieved through selective tuning of the brain rhythms to those stimulus streams (Calderone et al., 2014). In our longitudinal study with infants (n = 140) at the age of 6, 12 and 24 months, we aimed to examine whether similar mechanisms are at place in early development of selective attention. We used electroencephalography (EEG) to measure infant neural entrainment to covertly attended visual rhythms at 6 and 12 months, and a visual search task (Mulder et al., 2014) to measure selective attention at 24 months. We hypothesize that: (1) at 6 and 12 months, neural entrainment is stronger for relevant visual rhythms, as compared with distractors; (2) neural entrainment to relevant visual rhythms improves from 6 to 12 months, and; (3) neural entrainment to relevant visual rhythms at 6 and 12 months predicts selective attention at 24 months. At 6 and 12 months, infants viewed a task in which their covert attention towards one of the two peripherally presented rhythmic stimuli was cued by the gaze direction of a centrally presented face, while we measured their EEG. The two peripherally presented stimuli were identical, but flickered at two different frequencies (~ 3.5, 4.5, 5.5 and 6.5 Hz, depending on the condition). Infants viewed up to 60 trials, which lasted ~3.5 second each. We expected that infants' rhythmic brain responses to the frequencies of the visual rhythms consistent with the gaze direction will be stronger than to the inconsistent ones. At 24 months, the participants perform a computerized visual search task where they are presented with 48 animals on a 6 x 8 grid, and instructed to find as many targets (elephants) as possible while ignoring distractors (bears and donkeys). The participants complete up to 3 trials, each lasting 40 seconds. We expected that the scores (the average number of found targets across 3 trials) will be predicted by measures of neural entrainment to gaze-cued visual rhythms at 6 and 12 months. The EEG data from 6- and 12-month-olds has already been collected. The data collection at 24 months is in progress (n = 14 children tested so far). Preliminary analyses on a subset of 6-month-olds (n = 73) suggest that at that age, infants do not yet neurally entrain more strongly to relevant rhythms ($W(1) = 0.91$, $p = 0.34$ in a

Wald test in a mixed-effect model analysis). The presentation will include updated and longitudinal analyses on data from 6-, 12-, and 24-month-olds.

Abstract 7: Linking vestibular, tactile, and somatosensory rhythm perception to language development in infancy

First experiences with rhythm occur in the womb, with different rhythmic sources being available to the human fetus. Among sensory modalities, vestibular, tactile, and somatosensory perception (VTS; Provasi et al., 2014) plays a crucial role in early processing (Phillips-Silver & Trainor, 2005; Tichko et al., 2021). Specifically, the VTS system is the first to develop in utero (Bremner & Spence, 2017) and it contributes to the perception of rhythmic signals from intrauterine and extra-uterine environments through bone conduction (Sohmer et al., 2001; Granier-Deferre et al., 2011). Therefore, 'hearing' firstly occurs through VTS mechanisms shaping infant rhythmic experience in early stages of development (Phillips-Silver & Trainor, 2005; Rocha et al., 2021). However, a restricted corpus of studies focused on VTS rhythms in language development. Rhythmic discrimination abilities are part of a cognitive process that implies the extraction of hierarchical patterns of strong and weak beats alternating in time (Fitch, 2013), a cognitive ability that is crucial in processing rhythmic signals such as music and speech (Kotz et al., 2018). Therefore, testing this cognitive ability across sensory modalities will help to shed light on the extent to which rhythmic abilities might be considered as a set of general, cognitive and perceptual skills serving the processing of a vast range of signals (including music and language). On this ground, the present work investigated VTS rhythmic abilities and their role in language acquisition through two experiments with 45 infants (21 females, sex assigned at birth; M age = 661.6 days, SD = 192.6) with middle/high socioeconomic status. Thirty-seven infants from the original sample completed Experiment 1, assessing VTS rhythmic abilities through a vibrotactile tool for music perception. The vibrotactile, music-transduction system was specifically developed for this Study by adapting, for the first time to our knowledge, the Model Human Cochlea from Karam et al. (MHC, 2009) for infant subjects. The system translates auditory information into vibrotactile stimuli using two channels of voice-coils embedded in the seat-back of an infant high-chair. A frequency-based projection was chosen to resemble the tonotopic organization of the human cochlea, since the physical proximity to a sound source consists of the same energy (vibratory) used to encode auditory stimuli (Ammirante et al., 2016). In Experiment 2, linguistic abilities were evaluated in 40 participants from the same cohort, specifically testing phonological and prosodic processing. Discrimination abilities for rhythmic and linguistic stimuli were inferred from changes in pupil diameter to contingent visual stimuli over time, through a Tobii X-60 eye-tracker (Hepach & Westermann, 2016; Mathôt, 2018; Calignano et al., 2021; Russo et al., 2021). The predictive effect of VTS rhythmic abilities on linguistic processing and the developmental changes occurring across ages were explored in the 32 infants who completed both Experiments 1 and 2 by means of generalized, additive and linear, mixed-effect models (Baayen et al., 2008; 2017). Results are discussed in terms of cross-sensory (i.e., haptic to hearing) and cross-domain (i.e., music to language) effects of rhythm on language acquisition, with implications for typical and atypical development.

S.29 Perceptual Development—Insights from Infants Missing Vision, Hearing, or Hands

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Summary

We will examine the role of experience in refining perception and action by examining what happens when normal experience is missing because the infant is blinded by cataracts, deafened, or born without hands. First will come evidence that cataract-reversal patients show reduced audiovisual influences and reduced precision of auditory localization. Second will come evidence that, in congenitally deaf children fit with cochlear implants, visual and vibrotactile stimuli elicit EEG activity in auditory cortical areas that is correlated with difficulty of hearing speech-in-noise. Finally, will come evidence that adults born without hands activate regions of the association motor system usually selective for hand activities when performing the same activity with their feet. Collectively, the papers demonstrate the complex role for experience in early perceptual and motor development and the sometimes deleterious effects of cross-modal plasticity.

Details

Abstract 1, Title: Learning to See and Hear during Infancy: the Role of Visual Experience

Infants can see at birth but there are serious limitations on their vision, limitations that are gradually eliminated postnatally. Children treated for bilateral congenital cataracts afford an opportunity to deduce the role of visual experience in driving these postnatal changes. In the cohort we studied, the cataracts were dense and central, blocking all patterned visual input to the retina until they were removed and the eyes fit with compensatory contact lenses. Even when treatment was within the first 2–6 months of life, some aspects of vision never normalized, including visual acuity, contrast sensitivity, sensitivity to the direction of global motion, and recognition of facial identity (reviewed in Maurer, Lewis, & Mondloch, 2005).

Here we consider the possible contribution of altered auditory processing to the long-term visual deficits of cataract-reversal patients. As in the congenitally blind, auditory input stimulates parts of their cortex that are normally only visually-selective (Collignon et al., 2015). Perhaps as a result, cataract-reversal patients are faster than controls to respond to auditory stimuli and to switch attention from vision to audition (de Heering et al., 2016). However, they are less precise than controls in determining whether a flash and a beep were presented simultaneously, misjudging the timing when flashes are presented first (Chen et al., 2017).

Two new studies indicate additional deficits in cataract-reversal patients involving audition and its integration with vision. In the first study, we tested the audiovisual fission illusion (Shams et al., 2000) in which two beeps are presented at the same time as a single flash. Typically developed adults often perceive two flashes, with a stronger illusion in the periphery than in the centre of the field (Chen et al., 2017), perhaps because the system is primed to detect change in the periphery. Given the patients' visual deficits, we expected them to show a stronger than normal illusion. Instead, the illusion was of normal magnitude when the flashes were central and smaller than that of controls in the periphery. In fact, the patients' illusion was of comparable magnitude in both locations, unlike controls who showed the expected greater illusion in the periphery (see Figure 1A). Bootstrapping confirmed that patients did not show the normal pattern of a greater illusion in the periphery than in the centre.

In the second study, we tested auditory localization in a sound-attenuating chamber in a dark room. Two auditory clicks were presented in a random order on each trial: one click was always central, whereas the other was to the left or right by 3-15 degrees of visual angle. Participants indicated whether the

second beep was to the left or right of the first. Patients were less precise than controls in performing this exclusively auditory task (see Figure 1B).

Collectively, the data imply that early visual experience is necessary to set-up the neural architecture for the normal development of both visual and auditory processing and to allow their normal integration.

Abstract 2, Title: The Rewiring Brain: Cross-Modal Neuroplasticity in Hearing Loss

One of the most remarkable aspects of the brain is neuroplasticity, or the brain's ability to adapt in response to change. Sensory deprivation, as in hearing loss or deafness results in both structural and functional changes in the brain. One form of compensatory plasticity seen in sensory deprivation is cross-modal neuroplasticity. Cross-modal plasticity is a textbook example of the brain's ability to reorganize based on use. Cross-modal plasticity refers to the recruitment and repurposing of neuronal resources of a derived sensory modality by an intact modality. For example, in deafness, vision and somatosensation recruit and repurpose auditory cortical areas to enhance their own processing. The purpose of this talk is to characterize cross-modal plasticity in developmental deafness and hearing loss, and to determine how it can be exploited for improving clinical outcomes after neurosensory restoration with hearing aids and/or cochlear implants in infants and children.

Methods: We have examined cross-modal plasticity from vision and somatosensation using high-density electroencephalography (EEG) changes to visual motion and vibrotactile stimulation respectively in subjects with hearing loss and deafness. Subjects have included bilaterally congenitally deaf children fitted with cochlear implants, children with progressive unilateral deafness fitted with cochlear implants and adults with acquired mild-moderate hearing loss fitted with hearing aids (Campbell and Sharma 2016, Sharma et al., 2016, Cardon and Sharma 2019, Glick and Sharma 2020). All groups had age-matched, normal hearing controls. Behavioral measures included clinical hearing loss assessments, speech perception in noise evaluation and neurocognitive tests of global cognition, working memory, executive function and processing speed. Neuroplastic and behavioral changes were evaluated in subjects before and after treatment with hearing aids and cochlear implants.

Results: We see evidence of cross-modal reorganization from vision and somatosensation in all degrees of hearing loss (i.e., from mild hearing loss to profound deafness) and in both congenital and acquired hearing loss [See Fig. 2]. Across all subject groups, cross-modal plasticity is inversely related to scores on clinical tests of speech in noise perception. That is, greater evidence of cross modal plasticity appears to be associated with worse speech-perception-in noise ability. Furthermore, cross-modal plasticity may be negatively associated with cognitive outcomes. Thus far, we have seen reversal of cross-modal plasticity after cochlear implant use in unilateral (but not bilateral) deafness and after hearing aid use in mild-moderate hearing loss.

Conclusion: Overall, our research suggests that cross-modal reorganization is not a massive structural reorganization that is responsible for closing critical periods in deafness. Instead, cross-modal plasticity represents a neuronal process that is dynamic, versatile and reversible, resulting from existing sub-threshold multisensory inputs to sensory cortices and top-down influences on inhibition, which adaptively interacts with restoration of sensory loss. The developing auditory system is a model system for neurosensory restoration with neuroprostheses, and the dynamic and versatile nature of cross-modal plasticity can be exploited clinically for improving the outcomes of neurosensory restoration in infants and children with hearing loss.

Abstract 3, Title: Hand actions without Hands – Motor Plasticity in Congenital Handlessness

We perform most of our daily actions with our hands, and vast portions of the action system in the brain are dedicated to them. Hand loss due to amputation in adulthood requires difficult adaptation to compensate for the missing limb. What does this system do in people born without hands? What parts of the motor system can adapt to congenital handlessness and incorporate the intact motor output of other body parts, used as the acting effectors?

We studied, using fMRI, a unique population of people born without hands and arms who use their feet instead for daily actions. We examined their motor reorganization for simple body part movements, as well as the neuronal responses as they performed actions typically performed by the hands, such as tool use and grasping. These responses were compared to the organization in people with typically developed bodies, who performed the same actions with either their hands or their feet.

We found that many hand-selective brain regions in the association motor system (premotor cortex and parietal lobe, as well as parts of the cerebellum) do not represent the motor control of the hands themselves, but rather what actions are performed with them. This was found to be consistent in people who are typically developed and in people born without hands, suggesting that these higher-level representations in the parietal and frontal cortices allow action planning that is indifferent to the body part performing the action. This basis therefore allowed reorganization in the case of congenital handlessness.

Interestingly, the primary motor cortex did not show such motor indifference and did not show reorganization based on the body part used as an effector or main acting body part in people born without hands. This finding shows how brain plasticity for even congenital deficits may be limited based on the wiring of the brain at birth.

Together, these pieces of evidence point to a complex picture of brain plasticity in the case of partial loss of body or its control; the plasticity observed at different levels of the motor hierarchy differs based on the levels of representation typically present in each brain region. In other words, different levels of a system's hierarchy may be differentially affected by postnatal sensorimotor experience. Drawing parallels across the insights gained from studies of individuals born blind, deaf or without hands, I'll argue that studying such special populations allows tracking the cognitive level of representation of different brain regions and their hierarchies. Further, such research can open new avenues to use high-level action representations for motor rehabilitation and prosthesis design.

S.30 Computational Approaches to Early Language Development

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Summary

Computational measurement and modeling approaches are shedding new light on how infants acquire and use language in noisy naturalistic environments. Paper 1 finds that automatic (Whisper) transcription of teacher and toddler speech is reliable for both words and features in group care environments. Paper 2, using Whisper and Word2vec, indicates that parent words spoken to infants attending to an object are semantically related to the object name. Paper 3 finds that a self-supervised prediction algorithm learning from naturalistic audio requires attentional biases (e.g., to voices) to demonstrate a phoneme discrimination advantage. Paper 4 specifies the conditions under which an unsupervised model can acquire realistic phonemic and word discrimination, and referential word meaning, abilities. The discussant will contextualize the results of this international group of researchers with respect to advances and challenges posed by computational approaches to infant language development.

Details

Abstract 1, **Adult-Child Linguistic Interaction in Early Child Care: An Initial View from Reliable Automated Speech Transcription**

Introduction

Many infants and young children spend substantial time in early care settings. Little is known about their moment-to-moment linguistic interactions in these settings, in part because manual transcription of such interactions is an arduous task. We report on the reliability of OpenAI Whisper's transcriptions of recordings of preschool children and teachers, and compare Whisper and expert measures of teacher and child utterances, questions and responses, and the lexical alignment of those responses.

Method

Data were collected in three preschool classrooms focusing initially on four children (ages 3.9-4.7 years; three girls) and four teachers. Child audio (80 minutes) and teacher audio (35 minutes) was captured with individually worn stereo Sony recorders. Transcriptions were produced by Whisper's large-v2 multilingual model, an opensource audio-to-text neural network, and a human expert (see Figure 1). Speaker classification was done by the expert. We calculated word error rate (WER) separately for data from teachers' and children's recordings. All measures (e.g., mean length of utterance in words, MLU) were calculated separately for the Whisper and expert transcripts. We identified questions based on the occurrence of a question mark. We defined child responses to teacher utterances (both questions and non-questions) as instances of a child utterance that was the first utterance to follow a teacher utterance and was within 2.5 seconds of the preceding utterance. We likewise identified teacher responses to children's utterances. Finally, we calculated the proportion of responses that contained none of the words in the preceding utterance (0 alignment).

Results

All data are descriptive (see Table 1). The mean WERs were .19 for teacher speech and .16 for child speech, indicating that 81% and 84% of words, respectively, were transcribed accurately by Whisper. Teachers produced more than twice as many utterances as children. Mean MLU for teachers was 4.28 (Whisper) vs. 4.84 (expert); mean MLU for children was 4.26 (Whisper) vs. 4.05 (expert). The correlation between Whisper and expert MLU was r=.84 for teachers and r=.94 for children. Question vs. non-

question agreement was .93, *k*=.77. The proportion of teacher questions followed by a child utterance was .29 for Whisper vs. .31 for the expert; analogous proportions for teacher non-questions followed by a child utterance were .18 (Whisper) vs. .21 (expert). The proportion of child questions followed by a teacher utterance was .38 for Whisper vs. .37 for the expert; analogous proportions for child non-questions followed by a teacher utterance were .31 (Whisper) and .37 (expert). A high proportion of both teacher (Whisper=.65, expert=.74) and child responses (Whisper=.79, expert=.85) had no lexical overlap with the preceding utterance.

Discussion

Initial results suggest teachers produce many more utterances than children, but of roughly comparable MLU. Both teachers and children responded to roughly one-third of one another's utterances, and re-used the words in the previous utterance in about one-third of those responses (alignment). The relatively high reliability of Whisper with experts for key indices of language interaction provides support for the team's planned use of automated approaches to studying infant language development in early care settings.

Abstract 2, Learning semantic knowledge based on infant real-time attention and parent in-situ speech

Early word learning involves not only mapping individual words to their meanings but also building organized semantic representations among words. Previous corpus-based studies (e.g., using text taken from websites, newspapers, or child-directed speech corpora) demonstrated that linguistic information alone is sufficient to build semantically organized word knowledge. The present study explored two new research directions to advance our understanding of how infants acquire semantically organized word knowledge. First, an infant in the real world hears words surrounded by contextual information. Going beyond inferring semantic knowledge merely from language input, we examined the role of non-linguistic contextual information in learning semantic knowledge. Second, previous research relies on a large amount of linguistic data to demonstrate in-principle learning, which is unrealistic compared with child language learning. Here, we showed that incorporating non-linguistic information provides an efficient mechanism through which semantic knowledge can be acquired with a small amount of data infants perceive in everyday learning contexts, such as toy play.

Method. The data used in the present study were collected from 26 free-flowing parent-child play sessions with the same set of 24 objects. All infants were between the ages of 15 to 24 months (M = 19.3, SD = 2.1). During toy play, both infants and their parents worn head-mounted eye trackers to record momentary gaze data from the two social partners. After data collection, Whisper was deployed to automatically transcribe parents' speech into spoken utterances. We temporally aligned the speech utterances with infant sustained attention (defined as an unbroken look at an object that is longer than 3s) so that utterances, when infants attended to the same toy, were grouped into the same "bag" of words. Each "bag" of words was further cleaned by removing functional words without semantic meanings. In the following data analysis, we calculated the frequency distributions of individual words in each "bag" (see Figure 1) and used Word2vec to measure semantic similarities among words. A baseline condition was created by temporally shuffling the infants' sustained attention data and then grouping utterances based on the temporal alignment between the shuffled attention with parent utterances.

Results. We first calculated pairwise similarities of all the words in the same "bag" weighted by each pair's frequency, and found that those words in the same bag grouped by infant attention are semantically closer to each other than those grouped together in the baseline condition (*original* = 0.514, *shuffled* = 0.271, $t = 5.511$, $p < 0.001$, also see Figure 2A). Further, we calculated the weighted similarities between individual words in a "bag" and the attended object and found that those words grouped based on the same attended object are more semantically related to that object compared with those words in the shuffled condition (*original* = 0.645, *shuffled* = 0.245, $t = 6.827$, $p < 0.001$, also see Figure 2B).

Summary. The present study reveals a computational mechanism through which infant real-time attention on visual objects can be used to group semantically related words in parent speech across multiple spoken utterances over time. Our findings suggest that the integration of infant attention and parent in-situ speech can be an efficient way for infants to acquire semantic knowledge in everyday contexts.

Abstract 3, Computational models of early language acquisition from naturalistic data: a study-case on perceptual attunement

Introduction

Previous laboratory research suggests that infants' perception adapts to the sounds that are contrastive in their native language(s) (Tsuji & Cristia, 2014). The currently dominant hypothesis for this process of perceptual attunement posits that infants track the statistical distribution of speech sounds in their native language, which would in turn alter their perception (Maye et al., 2002; Kuhl et al., 2008). This hypothesis is supported by a myriad of computational studies showing that it is indeed possible to reproduce some developmental patterns observed in infants with statistical learning algorithms applied to a speech input (e.g., Vallabha, McClelland, Pons, Werker, and Amano, 2007; Schatz et al., 2021). A critical limitation of previous modeling studies is that they employ highly curated input, with even the most realistic computational approaches using studio recordings of conversations or audiobooks. However, infants' language environments differ significantly, more resembling a buzzing and chaotic mix of speech and non-speech sounds produced under challenging listening conditions rather than the polished speech signals found in studio recordings. This begs the question: Can one reproduce perceptual attunement when employing realistic input?

Methods & Population

Here, we present the first-ever attempt to model infants' perceptual attunement using a self-supervised prediction algorithm applied to naturalistic data. The algorithm learns audio representations by predicting the near future of audio sequences extracted either from 1) English or French audiobooks, or 2) ecological child-centered long-form recordings collected from American English- and Metropolitan French-learning children aged 2-48 months ($\mu = 14.9$ mo, $\sigma = 8.5$ mo). After exposure to one of these two languages, the learner undergoes a sound discrimination task from which two outcome measures are derived: 1) the native discrimination, measuring the ability of our learner to discriminate native sounds; and 2) the native advantage, measuring the extent to which the native learner better discriminates sounds of its native language than the non-native learner (a measure of perceptual attunement). See Figure 1 for an overview of the approach.

Results

We show that our prediction algorithm exhibits perceptual attunement when exposed to audiobook data used in previous modeling work. However, when exposed to naturalistic child-centered data, our learner loses native discrimination and fails to attune to its native language. Perceptual attunement only emerges when the prediction mechanism is supplemented with inductive biases that force the algorithm to learn speaker-, pitch-, and room-invariant representations and focus exclusively on speech segments. We argue that these inductive biases are plausible given previous research on infants and non-human animals.

Conclusion

We demonstrate that what our model learns depends exquisitely on the details of the input signal. Our results indicate that inductive biases, which help our algorithm cope with the sparse and noisy input signal, are necessary for perceptual attunement to emerge. While we know infants learn perfectly fine from such input, much remains to be understood about how they achieve this. Our study emphasizes the need for better integration of children's actual learning environment in our experiments and theories (e.g., by conducting in-lab experiments that more accurately reflect the speech infants are exposed to).

Abstract 4, Computational modeling of infant language learning from real speech, realistic number of audiovisual naming events, and without linguistic priors

Introduction

When learning their native language, infants face highly variable and non-discrete nature of acoustic speech. In fact, this variability can be seen as one of the major learning challenges in early language development. Despite decades of research, we lack a complete picture of how infants succeed in this process and how early language is represented in the learners' minds. In this work, we show that early phonemic and lexical learning can be modeled by using an audiovisual statistical learner that operates on real speech and visual input. We report results on simulations that model auditory and audiovisual learning up to 12 months of simulated infant age, demonstrating how successful phonemic and lexical learning can be achieved from real speech with general statistical learning mechanisms and without linguistic priors.

Method

A computational model based on unsupervised learning from auditory, visual and audiovisual input was used to simulate infant language learning. The model was first exposed to auditory speech corresponding to an average infant's cumulative speech input until 6 months of infant age. This auditory learning phase was followed by an audiovisual learning phase that consisted of visual input (photographs from real-world contexts) together with spoken descriptions of the photographs, simulating referentially ambiguous cross-situational learning from sights and sounds. We simulated 2, 4, and 6 months of audiovisual learning on top of the 6-months auditory learning to simulate up to 12-month-old infants. The number of audiovisual naming events and the frequency distributions of word types were closely matched with empirical statistics on real-world infant audiovisual experiences. We measured the model's competence in phonemic discrimination (using the so-called ABX-test), auditory lexical discrimination (for CDI early words), and referential word meanings (audiovisual forced-choice task for word referents) to quantify the model's language competence at different ages.

Results

The simulated 6-month-old auditory learner already acquired high phonemic discrimination capabilities (ABX error of 5.53%; chance 50%) and significantly above-chance word form discrimination capabilities (lexical score = 0.60 on scale 0–1; chance 0.012), replicating earlier work on auditory statistical learning. As expected, audiovisual word semantics were at chance (0.49; chance 0.5) before audiovisual learning. Analysis of the model at 8-, 10- and 12-month checkpoints revealed gradually increasing auditory lexical discrimination up to a lexical score of 0.81 at 12-months together with stable phonemic discrimination. The model's word meaning score reached 0.75 at 12 months of simulated age, corresponding to a receptive vocabulary size of approximately 40 words. The observed vocabulary growth at 8–12 months is comparable to receptive vocabularies of real infants of the same age (CDI statistics).

Discussion

The results demonstrate how early phonemic and lexical learning can be simulated with a combination of uni- and cross-modal statistical learning without any linguistic priors. The results also appear to be consistent with infant data from the comparable age range. Overall, the work showcases how modern computational models can be used to study the early language acquisition with increasingly realistic data in terms of quality (real speech and visuals) and quantity (amount of hours).

S.31 Pathways into joint attention: who leads, who follows?

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Summary

Joint attention (JA) is fundamental to successful social interaction and shared cognition. We know more about JA than ever before, but our understanding of how infants enter real-world JA remains limited: do they initiate JA, or follow their parent into it?

Much of the previous work has used structured lab-based tasks, which are significantly distinct from the unstructured, fast-moving complexity of social interactions. New techniques are beginning to enable us to explore, for the first time, the emergence of JA in real-world settings.

We combine 4 papers that use a variety of methodologies (eye-tracking, EEG, and vocal and motor behaviour) and contexts (home- and lab-based free-flowing interactions) to study how children and caregivers mutually adapt and influence each other's behaviour on a second-by-second basis to establish JA.

This work expands our understanding of the dynamics of real-world JA, with important implications for theories of how JA drives early language learning.

Details

Abstract 1: Who leads and who follows? The pathways to joint attention during free-flowing interactions change over developmental time.

Introduction: From very early on, infants begin to be able to coordinate their attention with a social partner in connection to a separate object or event. This phenomenon, known as joint attention (JA), has been found to correlate with many developmental outcomes. Despite universal agreement about its importance, little is known on how early naturalistic JA behaviours develop.

Hypotheses: Our aims are to (1) examine changes in naturalistic JA, (2) explore whether these changes are driven by infants becoming better initiators or followers, and (3) ask whether these changes are driven by developments in intentionally mediated forms of communication (i.e. increased looks to partner) or not.

Study population: Data were collected as part of the Oscillatory Neural and Autonomic Correlates of Social Attunedness project, an ERC-funded study following infants and their mothers during the first 30 months of life. The final sample for the current study includes 24 infants at 5 months, and 24 infants at 15 months, and their mothers.

Methods: We observed free-flowing tabletop toy play between infants and their mothers, and micro-coded their gaze behaviours at 50Hz. Tracking the momentary visual fixations of each participant allowed us to measure how often they attended to the same object at the same time and how they organised these JA moments. Data was analysed in a cross-sectional manner.

Results: Over time, episodes of JA increased in duration (average JA duration: 2.04s at 5M and 2.9s at 15M; $t(44)= -2.781$, $p= 0.007$). At both time points, most of the JA was driven by the mothers responding to the infants' initiations of attention rather than leading the infants' attention **(Fig. 1A)**. However, we observed developmental changes in these dynamics.

On the one hand, infants became more efficient leaders. Infant leader looks to JA as opposed to leader looks to non-JA increased **(Fig. 2A).** The probability of infants looking at the partner *before* leading a look and *during* an attentional look increased with time and made mothers more likely to respond to infants' looks **(Fig. 2B)**. These findings indicate that infants became better at signalling intention to share their attention with their parents. However, the proportion of infant parent looks *prior* to leading a JA episode was relatively small (~0.2 at 5M and ~0.4 at 15M) and thus, these looks can only explain a small proportion of the observed leading looks to JA episodes. On the other hand, we observed that older infants became better at following their partners' gaze. At 15M, infants were more likely to look at their parents *before* and *after* following a look. The proportion of these infant parent looks, however, was small (<0.5). Therefore, the increase in infant follower looks might only be partly explained by an increase in intentionally mediated infant behaviours.

Conclusion: Infants became better at leading as well as following their partners into JA. Older infants seemed more intentional; nevertheless, even at 15 months, JA was still predominantly achieved through mechanisms other than looking towards the partner.

Abstract 2: Proactive or reactive? Neural oscillatory insight into the leader-follower dynamics of early infant-caregiver interaction

Introduction: We know infants' ability to engage in joint attention is fundamental to language learning and social cognition (Donnellan et al., 2020). Yet, we understand little about the neural and cognitive mechanisms that drive shared attention episodes during early social interactions. A popular view has

been that, by the end of the first year, infants achieve joint attention through intentional, proactive communication; using ostensive signals to direct and share the attention of a communicative partner (Tomasello, 2010).

Here, we record EEG from infants during naturalistic play with their caregiver to investigate event-locked changes in neural activity before and after adult- vs. infant-led attention. It was hypothesised that, if infants proactively initiate joint attention, theta power, a neural marker of endogenously driven attention, would increase in the time before infant-led mutual attention; corresponding to an increase in infants' use of ostensive signals. Key to deliberately establishing joint attention is anticipating the partner's response to the initiation (Hamilton et al., 2021). Increased ostensive signalling was therefore hypothesised following infant-led attention, as well as increased alpha suppression; a pattern of neural activity associated with predictive processing in infancy (Monroy et al., 2019).

Method: Dual 32-channel EEG was recorded from infants and caregivers whilst they engaged in table-top-play with 3 toys. Gaze behaviour was coded offline and synchronised with the EEG signal **(Fig. 1A**). Thirty-seven dyads contributed data (mean infant age=11.12 months, *SD*=1.33).

Infant-led attention included moments infants gazed towards objects with which the adult was not already engaged; sub-divided into looks to mutual attention, where the adult followed, and nonmutual attention. Adult-led mutual attention included all looks where infants followed adults' attention towards an object. To compare attention episodes, EEG power (1-16Hz) 2000ms before and after look onset was extracted via continuous Morlet wavelet convolution, and averaged over fronto-central electrodes. The probability time-series of infants looking to their partner or vocalising 5000ms before and after look onset was also extracted.

Results: Our results indicated that infants were not predominantly proactive in creating episodes of mutual attention. Against hypotheses, theta activity (3-6Hz) did not increase in the 2000ms before infant-led looks to mutual attention, compared to adult-led looks, or infant-led looks to nonmutual attention: cluster-based permutation revealed no significant clusters at any frequency band. Behavioural time-series analysis indicated no increase in infant looks to their partner or vocalisations before infant-led mutual attention.

Infants did, however, appear sensitive to their gaze being followed by the adult. After look onset, a significant positive cluster of time*frequency points at alpha frequencies (5-9Hz; p=0.003) was identified; indicating reduced alpha activity in the time after infant-led, compared to adult-led mutual attention **(Fig. 2C-E**). There was little difference in infants' ostensive signalling post-look onset, and infant attention lasted longer during mutual attention, irrespective of whether the episode was adult- or infant-led.

Discussion: Our results suggest that at 10-12 months, infants are not yet proactive in creating joint attention. They do, however, anticipate behavioural contingency, a potentially foundational mechanism for the emergence of intentional communication (Smith & Breazeal, 2007).

Abstract 3: The Bidirectional Dynamics of Infant-Maternal Interactions during Joint Attention

Joint attention (JA), a cornerstone of early social development, is characterized by potentially bi-directional caregiver-infant interactions: caregivers may initiate a bid to redirect infant's attention (via gaze, pointing, vocalizations, and other actions) to a specific target (Butterworth & Jarrett, 1991); in addition, infants' behaviors can influence caregivers to redirect attention to their infants' focus (Chang et al., 2016; Yu & Smith, 2013). However, we understand little about the causal and temporal dynamics of events that shape these bidirectional interactions: for example, what events precede and facilitate infants following caregivers, versus caregivers following infants? Answering this would not only provide a more comprehensive grasp of infant-caregiver interactions during JA, but might also inform intervention strategies to promote communicative development in infants with developmental disorders. Thus, we investigated how infants' behaviors, including gaze and vocalizations, influence maternal behaviors during an unscripted JA task.

North American, English-learning infants (N=43) were videotaped monthly from 4 to 9 months of age at home in seated dyadic interactions with their mother. We micro-behaviorally coded and analyzed JA interactions (~3 min/session) to examine how infants' behaviors, including gaze and vocalizations, predicted mothers' subsequent JA behaviors. Notably, mothers' bids to redirect infants' attention were unscripted, and therefore could be influenced by infants' prior and/or concurrent behaviors. Our previous studies focused on the infants' responses (e.g., following) to mothers' bids; the current effort explores bidirectionality in JA, via time-series analyses of frame-wise changes in infants' behaviors, and their associations with different maternal attention-bid behaviors.

Our findings reveal bidirectional dependencies in JA behaviors as infants transition across months from primarily passive followers to active initiators of JA. Infants' gaze behavior exhibited a developmental shift: they paid decreasing attention to mothers' faces and hands from 6 to 9 months, while paying increasing attention to target objects. Notably, mothers' tendency to follow infants' gaze and reinforce infants' attention to the same target significantly increased from 6 to 8 months, indicating that mothers increasingly followed infants' attention to initiate JA episodes **(Fig. 2F)**. Furthermore, a linear mixed-effect model indicated that infants' gaze before a bid significantly predicted mothers' subsequent behaviors, prompting shifts in maternal attention when infants directed their gaze toward different targets **(Fig. 2G)**. In addition, infants' gaze towards a target before a bid significantly influenced mothers' strategies for centering infants' attention (e.g., touching the infant). Ongoing analyses are exploring how infant vocalizations affected mothers' pointing and looking behaviors during JA episodes.

This research advances our understanding of JA and triadic interactions by revealing the bidirectional nature of these interactions (Abney et al., 2021; Zukow-Goldring, 1990). Recognizing infants and caregivers as mutual co-constructors of JA enriches our comprehension of early interactions. More specifically, these results highlight the role of infants' gaze in shaping maternal responses during triadic interactions.

Abstract 4: The social boost of shared attention during everyday activities at home.

During naming moments that lead to real-time word learning, toddlers often attend to and/or hold the labeled object (Schroer & Yu, 2023). Given its importance for learning, how can toddler's attention during naming instances be supported? One pathway is through shared attention (SA), when toddler and parent look at the same object at the same time. Lab-based research has found that when parents join their child in looking at an object, that bout of toddler attention is extended (Yu & Smith, 2016). This

social boost of SA is even greater when parent behaviors are multimodal (looking, holding, speech; Suarez-Rivera, Smith, & Yu, 2019). But the real environment of toddler learning is noisy, cluttered, and opportunities for SA may be infrequent. In this study, we asked whether the social scaffolding of SA occurs at home during moments when it may matter the most – increasing toddler attention to the correct referent-label mapping. And, if so, does multimodal coordination further support attention?

We brought wireless head-mounted eye trackers to families' homes to get 1-hour recordings of their daily lives, with toddlers (24- to 36-month-olds) and a parent wearing the eye trackers (**Fig. 1B**). We sought to maximize the naturalness of the recordings, so additional family members could be home, families could do whatever they wanted during the recording and speak the language(s) most comfortable to them, and experimenters were not in the house during the recording session. All participating families (N=6) engaged in object play and mealtime during their recordings, so our analyses focus on these two activities. Within object play and mealtime, we transcribed parent speech and object naming, coded parent and toddler visual attention, and parent and toddler object handling.

The goal of our analyses was to test whether the social boost of SA occurs in the real world. We identified when parents named objects and measured the proportion of the utterance that the toddler was visually attending to the named object. To test whether SA affects visual attention, we categorized naming utterances by the type of SA that occurred in the two seconds BEFORE the naming utterance began: no SA, just SA, SA with the toddler holding the to-be-named object, SA with the parent holding the to-be-named object, and SA with both toddler and parent holding the to-be-named object. We compared the amount of toddler visual attention during naming using linear mixed effects models with subject as a random effect. We found that multimodal shared attention, SA that is accompanied by the attended object being held, increased the toddler's attention to the labeled object during naming – but that unimodal SA had no effect on toddler attention (**Fig. 2 H-I**).

Our results suggest that in the real world, where toddlers' environments are more cluttered and noisier, the social boost of SA still exists, but that hands play a critical role in coordinating parent-toddler behaviors and resolving ambiguity of naming moments.

S.32 Improving transparency, reproducibility, and generalizability: Methods for characterizing infant behaviors and experiences

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Summary

Infant researchers can capitalize on a variety of rich methods and tools to assess learning and development. The four speakers in this symposium showcase different methodological approaches for documenting infant and caregiver behaviors. Talk 1 showcases how to collect **ecological momentary assessment** data to capture infants' experiences across nested timescales. Talk 2 describes a rich repository of **daylong audio recordings** (HomeBank) of infants at home that researchers can use and to which they can contribute new data. Talk 3 relays how **video recordings** of infant-mother home activity—hundreds of hours across US geographic regions—can be leveraged for documentation and open sharing. Talk 4 provides a **comparison of laboratory and naturalistic methods** to assess

replicability and generalization of findings on triadic interaction. Collectively, talks emphasize the need to capture valid, high-quality data on infants' behaviors and experiences to ensure transparent and reproducible science.

Details

From instants to experiences: How ecological momentary assessment can characterize infants' everyday activity; Despite growing consensus about the importance of measuring the content of infants' day-to-day lives, such measurements remain difficult to obtain. Ideally, experience measurements should: 1) reflect variability in infants' activities within and across days (unbiased sampling of each individual's behavior), 2) test large, representative samples of participants (unbiased sampling of individuals from the population), and 3) provide rich data from direct observations. Existing techniques satisfy some (but not all) three criteria. Making home visits to video-record infants provides rich data, but short and laborious observations can only capture one part of the day. Wearable sensors (e.g., LENA, actigraphy) can record continuously across multiple days, but are difficult to scale to large, representative samples. Surveys scale well but lack the richness and immediacy of direct observation.

In the first part of the talk, I will argue that ecological momentary assessment (EMA) provides the best current compromise to meet all three criteria. Unlike continuous recording (i.e., videos, sensors) or retrospective surveys, EMA asks respondents to make instantaneous observations of infants' behavior by answering repeated, discrete prompts. I will draw examples from two published studies and three ongoing studies to highlight the variety of sampling procedures and dependent measures suitable for EMA. Across studies, we notified caregivers via text message or smartphone notifications multiple times per day (5-12) over multiple days (4-14) at semi-random intervals to answer 1-minute surveys and/or to record short videos of infants' behavior. Survey questions asked caregivers to make direct reports about infant sleep, body position, device use, manual action, social environment, and daily routines (e.g., playing, feeding, errands) at that moment. High compliance (72-95% of prompts answered) and timely responses (1-2 min media response time) uniformly distributed across the day meant that responses met the goal of gathering unbiased samples about each infant. Collecting data from large, diverse samples (considering race, ethnicity, geographic location, and SES) suggests the potential for EMA to test representative samples at scale. Short video recordings provide even richer data for categorizing infant locomotion and the frequency and variety of experiences with household objects and toys (Figure 1).

In the second part of the talk, I will address an underlying assumption about EMA—that aggregating across a sufficiently large number of randomly-dispersed, discrete observations produces accurate and precise estimates of how infants spend their time. Using existing data about the time infants spend in different body positions (e.g., prone, supine, sitting, and upright), I conducted a series of simulations to create participant-inspired time series of continuous behaviors. From those time series, I estimated the proportion of time spent in each body position based on 40 randomly distributed discrete samples to compare with the true value. Margins of error (95% CI) of EMA-derived estimates of time spent in each body position ranged from 5% to 10%, precision, sufficient for making comparisons about the relative frequency of different behaviors. Finally, I discuss how researchers can programmatically design EMA sampling schemes to navigate the trade-off between participant burden/compliance and measurement precision.

HomeBank: Making daylong home audio recordings widely available; Daylong home audio recordings collected using infant-worn devices are transforming the study of infant behavior and audio environments. For instance, they enable characterization of patterns of infant vocalization over the course of both short and long timescales, quantification of different types of adult input across a diverse and ecologically representative range of real-world contexts, and new opportunities and challenges for the development of machine-learning-based audio classification. Likewise, open data repositories are transforming developmental science by enabling data to be inspected, reanalyzed, and combined across study publications and by enabling access by researchers who may lack the institutional or other resources to perform data collection, facilitating diversity among both participants and researchers.

HomeBank enables researchers to share daylong child-centered audio recording data with a wide user base. It utilizes several practices to help protect participant privacy and the dignity of participants from under-represented or disadvantaged populations. These include a tiered access system and a membership process that includes among other elements a video meeting with prospective users to promote sincere consideration of ethical issues and associated practices.

HomeBank has accumulated 17 unique corpora and 5 unique datasets (Table 1) building on one or more of those corpora, with a range of languages and special populations. Approximately 100 principle investigators have become HomeBank members, giving them and their supervisees access to password-protected data.

These data have been used by members in several high-impact papers, often combining across corpora to address questions such as how financial stress relates to children's language input (Ellwood-Lowe et al., 2021), how quantities of child vocalization and adult child-directed and adult-directed speech change with child age (Bergelson et al., 2019), and how infant canonical babbling emerges with increasing infant age across cultures (Cychosz et al., 2021). HomeBank data have also been used in multiple audio machine learning challenges featured at the annual Computational Paralinguistic (ComParE) Challenge, facilitating the development of new algorithms for identifying infant-directed speech and infant canonical babble.

Since its establishment, several particular challenges and solutions have emerged. For example, data contribution requires researchers to be intentional in their informed consent process at the outset of the study (Gilmore et al., 2020). We offer specific recommendations to researchers about how they can at study outset enable the possibility of data sharing in a way that permits flexibility and efficiency while still providing participants with control over their level of data access. Other challenges include (1) long-term maintenance and stewardship of the project and (2) integration and version control of human- and machine-generated annotations.

Our aim in this presentation is to educate participants about the HomeBank resources available to them, either as data users or as future data contributors, and to stimulate discussion and input on how to improve this and related projects for the benefit of diversification of infant development research and for scientific progress.

Ensuring high quality video data in big team science: Quality assurance and curation; For infancy research, videos with identifiable information serve multiple roles—to document methods, train experimenters, ensure protocol fidelity, and provide curated, ethically-shared data for broad reuse. The scope of video sharing can scale from a single lab to a network of collaborators; the kinds of videos can

range from a short in-lab task to a battery of observations in participants' homes. All of these videos can be permissioned for open sharing with the scientific community to accelerate discovery and enhance transparency and reproducibility.

We describe best practices for video data use and reuse by illustrating the infrastructure and workflow of our Play and Learning Across a Year (PLAY) project—which generates videos of 1-hour of natural home activity, 5-mins of structured play, home tours, and questionnaires (e.g., vocabulary, motor skills, temperament, parent and child health, household gender roles) from 1000 infant-mother dyads. 70+ investigators designed and vetted the PLAY protocol. A central team remotely trained 32 data collection sites across the U.S. Videos of entire visits, recruitment phone calls, and detailed instructions for data curation serve as training materials and protocol documentation (play-project.org).

Every family (*N*=397, data collection ongoing) gave permission to share raw, identifiable videos on Databrary.org. Videos, demographics, and questionnaires are curated and uploaded by data collectors after each visit. Tablet-based apps serve as aids for file organization and labelling. Each session is routed to the central PLAY team; a two-phase quality assurance (QA) process ensures protocol adherence and useable data for transcription and behavioral coding. First, in "heavy" QA (6-8 hours per session), central PLAY team members provide feedback on all videos from a session. They mark whether and why a session fails QA, following specific, openly shared criteria. Second, after 2 passes on heavy QA per data collector, they conduct "light" QA (2 hours per session) and pass the session or revert to heavy QA pending major issues. Team members provide feedback to researchers at each site through time-locked annotations in Datavyu and in electronic "tracking" spreadsheets with commentary on all aspects of the protocol. Tracking spreadsheets inform sites on their ongoing progress toward collecting their PLAY sample.

High-quality big team data is possible: after training and piloting, of the visits that met inclusion criteria 362 (91.2%) passed QA. Video recording was not intrusive: Only 12 infants (3% of all sessions) were distracted by the presence of the experimenter. Videos, questionnaires, and QA notes—even from sessions failing QA—will be openly shared with authorized investigators on Databrary. Our approach to quality assurance ensures fidelity to the protocol—whether in a single lab or in 100 labs. Our synergistic approach to distributed data collection and central oversight of quality assurance facilitates data harmonization across sites and is especially valuable for studies with special populations where each data session is precious.

The value of natural behavior for reproducibility and generalizability; There is a long history of studying natural behavior in infant research. Observational studies are criticized as not rigorous and objective. Instead, the experimental psychology approach has developed and dominated lab research in the past few decades. The field of developmental science has succeeded in mastering highly controlled laboratory methods that exquisitely test developmental theories in relatively pure settings. A current challenge is to examine whether those findings from laboratory experiments can be generalized to natural behaviors in naturalistic settings that are noisy, unpredictable, and replete with error. The present study addresses this challenge by analyzing and comparing gaze data collected in different study settings and from diverse developing populations.

The Original Study. Fifty-one parent-toddler dyads with toddlers aged 11 to 24 months played with two sets of toys (three toys in each set). Head-mounted eye trackers were worn by both participants, allowing us to record the eye-in-head position of both infants and parents during play. Gaze to and hand

actions on objects by parents and infants were recorded and coded. In the results reported by Yu & Smith (2017), we found that a substantial proportion of time in free play was spent when the dyads jointly attended to the same object. In both child-led and parent-led joint attention episodes, JA instances have been achieved not only through gaze following but also through the coordination of gaze with manual actions on objects as both infants and parents attended to their partner's object manipulations.

Replication and Generalization. Since the original study, we have conducted three follow-up studies within the same context of free-flowing parent-infant toy play: 1) Study 1 — from white room to toy room: 37 parents and infants played with a set of 24 toys on the floor, in a room decorated as a toy room; 2) Study 2 — from younger to older children: 30-month-olds and their parents participated in the study; and 3) Study 3 —from typical developing populations to atypical developing populations: A group of children with Autism and their parents were asked to engage in the same toy-play task. The results from the three studies essentially replicated the findings from the original study. The dyads consistently employed multiple pathways to establish joint attention. Further, they relied more on hand-following pathways than the gaze-following pathway.

In summary, we suggest that findings are likely to be replicated in the same context and further generalized in other contexts if a lab study is designed to understand natural behavior (e.g., free-flowing child-parent interaction) but not designed to elicit a specific behavior in a specific and constrained context. Compared with findings from tightly controlled experiments, the results derived from natural behavior can be remarkably reliable and generalizable, which provides a useful way to address the reproducibility crisis and a leap forward in understanding development and learning.

S.33 Early pathways to neurodiversity in infants at elevated likelihood of autism and/or ADHD

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Summary

Autism and Attention Deficit Hyperactivity Disorder (ADHD) have a 1-5% prevalence rate in the general population, affecting ~3 million people in the UK. Whilst both conditions are diagnosed in early childhood, parents often notice autistic traits in the first 12 months, contacting services within the first 2 years. Early identification of neurodevelopmental conditions is key in providing sufficient support for diagnosed individuals, with earlier intervention often leading to better outcomes and quality of life. In this panel, we examine the early biomarkers of autism/ADHD. We bring together research from several cohorts with an elevated likelihood of developing these conditions (e.g., infants with a parent/sibling with a diagnosis and infants with Tuberous Sclerosis or Neurofibromatosis Type 1), who have a ~20-50% chance of developing the condition themselves. We present work on sleep, sensory atypicalities, temperament and the developmental profile of autism in these cohorts.

Details

Abstract 1 Title: Early sensory processing and autism traits in infants diagnosed with Tuberous Sclerosis Complex

Background: Tuberous sclerosis complex (TSC) is multisystem genetic disorder which is highly comorbid with epilepsy (Yates et al., 2011) and a leading cause of syndromic autism, occurring in up to 60% of cases (Samanta, 2020). Evidence of sensory dysregulation, in particular hypo- and hyper-sensitivity in children with autism (Marco et al., 2011), suggests atypical sensory modulation may be present in early TSC, however this has not yet been determined. Sensory sensitivity has also been linked to childhood epilepsy (Van Campen et al., 2015) and may influence the relationship between sensory processing and autism.

Objectives: Such gaps in TSC literature call for early prospective measurement of sensory processing in TSC in order to better understand precursors of neurodevelopmental outcomes, such as autism.

Methods: The Early Development in Tuberous Sclerosis (EDiTS) study involved completion of home visits at 3, 5, 8, 10, 14, 18 and 24 months of age to collect data on infants' behavioural and neurocognitive development. Infants with TSC (n=32) and typically developing (TD) infants (n=33) were recruited up to 14 months of age. Parent-report questionnaires and interviews were used to collect data on: (1) Sensory hyper- and hypo- sensitivity (Infant Toddler Sensory Profile) at 10, 14 and 24 months old, (2) autism traits (Quantitative Checklist for Autism in Toddlers) at 14, 18 and 24 months old, and (3) epilepsy presence and severity (Early Childhood Epilepsy Severity Scale) at all timepoints. Preschool autism outcome data at ages 3-5 years old will be made available in 2024 for further analyses.

Results: At 14 and 24 months old, infants with TSC showed increased atypical sensory seeking behaviours compared to TD infants (Cohen's d=.626 – .882, p=<.02), and increased sensory hyposensitivity scores at 24 months old (Cohen's d=.889, p=.002). No group differences in hypersensitivity scores were observed at all timepoints (p>=.302). Increased sensory seeking behaviours in 14 month old infants with TSC predicted higher Q-CHAT scores at 24 months old (p=.008), after controlling for epilepsy presence (p=.012), however not when accounting for epilepsy severity at 14 months old (p=.292). Concurrent hyposensitivity behaviours and Q-CHAT scores at 24 months old were also positively correlated (p<.001).

Conclusion: Early signs of decreased sensitivity to sensory input in the second year of life in infants with TSC may be associated with early autism traits in toddlerhood. However, epilepsy severity is likely to play a greater role in understanding factors which increase the likelihood of later autism emergence in TSC. Given the high comorbidity between TSC and autism, characterising atypical sensory behaviours in infancy is important for understanding behavioural correlates of later autism diagnoses and developing targeted support.

Abstract 2 Title: Sleep onset problems in infancy associates with later increased sensory sensitivity and Autism Spectrum Disorder symptomatology

Background: Sleep problems have been implicated in neurodevelopmental disorders, such as Autism Spectrum Disorder (ASD), persisting from early development to adulthood (Rydzewska et al., 2020). Previous research examining prospective longitudinal cohorts have found that infants with a family history of ASD, and those that go on to have an ASD diagnosis, demonstrate reduced levels of night sleep (i.e., reduced sleep durations, increased night awakenings and increased sleep onset problems),

with reduced night sleep in infancy associating with later increased ASD symptomatology and reduced social communication skills (Begum Ali, Gosse et al., in press; MacDuffie et al., 2020). Further, sleep disturbances in ASD cohorts have been associated with increased sensory atypicalities (e.g., Holway et al., 2013; De Laet et al., 2022). As such it is important to examine sleep in development and its relation to emerging sensory differences.

Objectives: To examine sleep and sensory behaviours concurrently and longitudinally in the first 2 years of life in infants and toddlers with a family history of ASD.

Methods: We collected parent-report questionnaires from a sample of 247 infants; 170 infants with an elevated likelihood of ASD (ASD-L) and 77 infants with a typical likelihood of ASD (TL).

We assessed sleep using the Infant Sleep Onset Problem score (ISOP; MacDuffie et al., 2020) derived from the Infant Behaviour Questionnaire Revised (Putnam et al., 2014) at 4, 6-10 and 12-15 months of age. To examine sensory behaviours, we used the Perceptual Sensitivity subscale (PSS) from the IBQ-R (4-15 months) and the Early Childhood Behaviour Questionnaire (24-months; Putnam et al., 2006).

Results: Sleep Onset Problems did not vary by familial likelihood of ASD [$F(1, 314) = .25$, $p = .62$)] or ASD Outcome at 3 years [$F(1, 403) = 1.31$, $p = .25$]. To investigate the relationship between sleep and sensory behaviours, we used a cross lagged structural equation model. We found that increased Sleep Onset Problems at 12-15 months associated with increased Perceptual Sensitivity at 2 years ($\beta = .14$, $p = .03$) and increased ASD symptomatology (Social Responsiveness Scale scores: $\beta = .2$, $p = .004$) at 3 years; see Figure 1.

Conclusions: Our findings show that increased levels of sleep problems in infancy associate with increased sensory sensitivity and ASD symptomatology in toddlerhood. Interestingly, we find no group differences in the sleep measure used.

Abstract 3 Title: Temperament profiles for transdiagnostic predictions across the first five years of life

Background: Temperament refers to early emerging differences in emotion reactivity and self-regulation that result from interactions between biological, genetic and environmental factors[1]. Previous research has uncovered some group differences in negative emotionality and effortful control between infants and preschoolers with, or at elevated likelihood of, neurodevelopmental conditions such as autism[2] and ADHD[3]. However, evidence of diagnostic specificity is inconsistent [4], and recent meta-analyses suggest that negative emotionality and self-regulation may act more broadly as transdiagnostic markers for later behavioural difficulties[5]. Further research is needed to understand the interplay between these processes across development in predicting variability in clinical outcomes both within and across categorical diagnostic boundaries.

Objectives: Using data from two large developmental cohorts enriched for neurodivergence, this study aims to: 1) identify subgroup classifications based on temperament dimensions of negative emotionality and effortful control in infants and preschoolers, and 2) investigate how these temperament profiles relate to variability in transdiagnostic clinical outcomes (adaptive function and behaviour difficulties) both cross-sectionally, and longitudinally.

Methods: Data from two separate cohorts was collected as part of a large European network studying autism, and related conditions, across the lifespan. Cohort 1 included 10-month-old infants with (N = 151), and without (N = 27) a family history of ADHD and/or autism, with preschool follow-up data collected at 3 years of age[6]. Cohort 2 included 419 preschoolers aged between 2 ½ to 5 years old (163 autistic children, 174 neurotypical children, 40 children with developmental delay, and 42 children with ADHD)[7]. Temperament was assessed using Rothbart's standardised parent-report questionnaires for the relevant age range: the Infant Behaviour Questionnaire (Cohort 1), and the Child Behaviour Questionnaire (Cohort 2, and preschool follow-up of Cohort 1). Transdiagnostic clinical outcome measures included adaptive functioning (Vineland Adaptive Behaviour Scale), and behaviour difficulties (Child Behaviour Checklist; Strengths and Difficulties Questionnaire).

Results: Data collection and quality control will be completed in December 2023. Results will be available for the ICIS 2024 conference. Descriptive statistics for the temperament subscales in both cohorts to date are shown in Table 1. Preliminary analyses with a subset of data (N = 54, Cohort 1) indicated no significant differences associated with ADHD likelihood status in effortful control, $F(1, 52) = .51$, $p = .48$, $\eta_p^2 = .010$, or negative emotionality, $F(1, 50) = 3.39$, $p = .072$, $\eta_p^2 = .063$, at 10-months of age, supporting the transdiagnostic approach used in this study. Latent profile analysis will be used to identify subgroup classifications on temperament dimensions of negative emotionality and effortful control in infants using the Infant Behaviour Questionnaire (Cohort 1), and preschoolers using the Child Behaviour Questionnaire (Cohort 2). We will compare the subgroup classifications on transdiagnostic outcome measures of adaptive function and behaviour difficulties cross-sectionally in pre-schoolers (Cohort 1 and 2), and examine whether subgroup classification can longitudinally predict behaviour difficulties from infancy to preschool (Cohort 1).

Conclusions: Examining how temperament profiles relate to variability in behavioural difficulties in diverse populations of infants and young children could guide the development of early support strategies.

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Abstract 4 Title: Developmental trajectories in infants and pre-school children with Neurofibromatosis 1

Objective: This prospective cohort study examines the cognitive, behavioural, social and attentional development in infant and pre-school children with Neurofibromatosis 1 (NF1) compared with children without a family history of neurodevelopmental conditions (controls).

Methods: Children with NF1 and controls were enrolled from 5 months of age. Data from standardised tests was gathered at 5,10,14,24 and 36 months of age (NF1 n=35, control n=29). Developmental trajectories of cognitive and adaptive behavioural development from 5 to 36 months were analysed using linear mixed modelling to estimate group differences over time, along with attentional development from 24 months. Descriptive analyses of social communication development at 24 and 36 months were conducted.

Results: Cognitive skills (Mullen Scales of Early Learning) were significantly lower in children with NF1 at each time point compared with controls. The developmental trajectory over time of cognitive skills also differed significantly between children with NF1 and controls. Adaptive behavioural skills were significantly different in infants with NF1 when compared with typically developing controls on four subscales of the Vineland Adaptive Behaviour Scale. The NF1 cohort demonstrated significantly higher levels of inattention but remained below a diagnostic threshold on the CBCL.

The NF1 cohort was significantly more likely to demonstrate social communication concerns on the ADOS/BOSA at 24 months compared to controls. However, these differences did not reach significance at 36 months.

Conclusions: Our results demonstrate that overall cognitive, adaptive behavioural and attentional trajectories differ significantly in the NF1 group compared with controls. Social differences are more pronounced at 24 months, however these differences became non-significant at 36 months. Future research should confirm these findings with larger sample sizes. This is the first study to investigate trajectories of cognitive and behavioural development in children with NF1 from infancy up to pre-school age using parental report and objective assessment measures.

S.34 Malnutrition and its association with the gut microbiome, brain development and behavioral outcomes

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Summary

Acute malnutrition affects ~45m children <5y globally (WHO, 2020) and elevates the death risk 11-fold (UN). Accordingly, and given malnutrition's lasting impact on surviving children, addressing malnutrition in severely affected countries like Bangladesh is vital.

To examine the consequences and evaluate nutritional interventions, we conducted a longitudinal randomized controlled trial (RCT) in Bangladesh (NCT05629624). The symposium will feature 3 presentations, focusing on fNIRS (functional connectivity), EEG (power spectral density), and gut microbiome data respectively, collected from acutely malnourished (N= 150) and well-nourished (N= 75) 1-year-olds enrolled in the RCT.

Both, brain connectivity and power were sig. different between groups. Also, both brain measures were positively related to BAYLEY language scores. AI analyses including gut microbiome data, plasma lipids, and EEG data effectively predicted BAYLEY language scores and identified links among all variables.

Details

Abstract 1, Title: Exploring the relationship among malnutrition, brain connectivity and behavioral outcome in young Bangladeshi children using fNIRS

Malnutrition affects millions of children under 5 in Bangladesh (UNICEF), with particularly profound consequences during infancy, when the brain architecture supporting the development of cognitive and social-emotional skills is built. Recent findings have begun to unveil the impact of malnutrition on brain development (Turesky et al., 2020; Xie et al., 2019). Hence, it is likely that nutritional deficiencies during infancy may affect cognition and behavior throughout childhood, possibly leading to long-term consequences into adulthood (Prado & Dewey, 2014). While a wealth of research has been conducted in low- and middle-income countries (LMICs) on the behavioral outcomes of children facing adverse circumstances (e.g., malnutrition), few studies have attempted to probe the mechanisms underlying links among malnutrition, brain development, and behavioral outcomes in LMICs.

Our study uses fNIRS to investigate how functional brain connectivity (FC) in 12-month-old Bangladeshi children is related to malnutrition and investigates relations to behavior. During our fNIRS paradigm, we recorded brain activity from 42 channels covering fronto-temporo-parietal areas, while infants passively watched a 10-minute nonsocial cartoon. We indexed malnutrition using weight-for-length/height z-scores (wasting), a common metric to assess acute malnutrition in LMICs. To index behavioral outcome, we used the Bayley Scales of Infant and Toddler Development, a gold-standard tool to assess early cognitive performance which has been previously deployed in Bangladesh (Tofail et al., 2013) as well as other measures of executive functioning (e.g., inhibitory control tasks). While the processing of the behavioral assessments is ongoing, here we show preliminary analyses on the FC patterns measured in acutely malnourished children and in well-nourished children. We estimated FC between the regions of interest

covered by our headcap (ROIs are currently defined using DevFold, Fu et al., 2021). First, we compared FC patterns (Oxy-hemoglobin) between the two groups. Next, for each group, we correlated FC measures with the Bayley raw scores obtained from cognitive, expressive, and receptive communication scales.

Our analyses revealed that acutely malnourished children displayed higher FC between left fronto-temporal and fronto-parietal regions compared to well-nourished children (all p*s*<.05). Furthermore, we found several significant positive correlations between FC and the Bayley scores indexing expressive and receptive communication for the well-nourished group, while no correlation reached significance for the acutely malnourished group (all p*s*<.05). These preliminary results highlight the critical effects of malnutrition on brain development, which in turn seems to affect behavior. Possibly, malnourishment suppresses the brain-behavior relations emerged for the well-nourished group. Notably, this simple fNIRS task shows sensitivity in identifying language differences between these groups.

Abstract 2, Title: Malnutrition is associated with decreased brain activity measured by EEG and behavioral outcomes in Bangladeshi infants exposed to early adversity

Malnutrition's extensive consequences include profound effects on the developing brain, especially during infancy. For example, using high density EEG, Xie et al (2019) demonstrated an association between growth faltering and altered EEG functional connectivity (FC) in 36-month-olds, which was further associated with poorer cognitive outcomes at 48 months (Xie et al., 2019). The same study did, however, show no significant association between malnutrition and EEG FC at 6 months of age or any further association with cognitive outcomes at 27 months.

To examine the age at which malnutrition starts to affect the brain (electrophysiology) and to determine whether early intervention can reverse these patterns, we studied 12-month-old malnourished as well as well-nourished children (control cohort) from an urban impoverished neighborhood in Dhaka, Bangladesh (similar to the sample in the Xie et al., 2019 study). After the 12-month baseline, the malnourished children received a nutrition intervention and currently all children are followed-up at 24 months of age.

To examine associations among children's (mal)nutrition, brain electrophysiology, and cognitive development at the 12-month baseline, we collected growth measurements (weight and length/height), 3-minute resting state high-density EEG, as well as cognitive outcomes (Bayley Scales of Infant and Toddler Development (BAYLEY)). Weight-for-length z-scores (WLZ) were calculated based on the World Health Organization standard. EEG data was processed using the Harvard Automated Processing Pipeline for Electroencephalography (HAPPE) (Gabard-Durnam et al., 2018) to extract EEG power spectral density (PSD) in different frequency bands for a frontal region of interest. Finally, explorative independent measures ANOVA and linear regression were conducted to test the differences and associations between variables.

We found that moderate acute malnutrition (MAM), i.e., a WLZ score that is 2 standard deviations below the median of the WHO reference, was negatively related to EEG PSD in the high alpha (9-12Hz), beta (12-30Hz) and gamma (30-45Hz) range (see Figure 1a). Across malnourished and well-nourished children, in turn, EEG PSD in the theta (4-6Hz) and alpha (6-12Hz) range was positively related to children's expressive communication BAYLEY scores (see Figure 1b).

The observed association between MAM and brain electrophysiology likely reflects a broad negative impact of malnutrition on children's brain development at 12 months of age. The association between

brain electrophysiology and the expressive communication score, in turn, provides a first indication that electrical brain activity is (one of) the neural pathway(s) through which biological adversity affects cognitive development. Furthermore, the results indicate that one of the behavioral outcomes whose development is most affected by malnutrition in 12-month-old children seems to be expressive communication, as the BAYLEY scores for cognition and receptive communication were not significantly associated with EEG PSD in this study.

Abstract 3, Title: Linking the gut microbiome to neurocognitive development in Bangladeshi malnourished infants

Malnutrition is a significant global health issue that affects millions of infants every year. Malnutrition has serious implications on neurocognitive development, leading to long-term deficits in learning, memory, and behavior (Udani, 1992). While much is known about these implications, there remains a crucial need to understand the mechanism by which they arise.

To this end, we trained multimodal AI Random Forest classification models with a combination of gut microbiome species and functional profiles, plasma lipidomics, and electroencephalogram (EEG) power spectral density (PSD) from 1-year-old infants with Moderate Acute Malnutrition (weight-for-length between –3 and –2 z-scores of the WHO Child Growth Standards median) and non-malnourished infants to predict neurocognitive development; specifically to classify high and low quantiles of BAYLEY Expressive Communication (EC) scores. Data were obtained as part of the M4EFaD trial, run in Dhaka, Bangladesh (NCT05629624).

The models predict EC effectively (AUCROC = 0.71). By interpreting these models, plasma lipids had the highest proportion of highly predictive features. Interestingly, presence of *Bifidobacterium* species in the gut and their anaerobic fermentation pathways were strong predictors of high EC (SHAP score = 0.20). Through co-abundant network analysis, *Bifidobacterium* species were correlated with plasma fatty acids and gamma frequency EEG power forming a distinct cluster involved in the breakdown of cholesterol esters and sugars for sphingomyelin and ceramide biosynthesis - essential precursors for cognitive maturation (Jiang et al., 2021 - Figure 2). Depletion of this cluster was predictive of malnutrition.

The intricate and non-overlapping connections among gut microbiome composition, nutritional status, and brain activity highlight the significance of targeted interventions in addressing both the short and long-term impacts of malnutrition.

S.35: Understanding infants' speech processing: the role of input and development in neural oscillation and prosodic phrasing across languages

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Details

Abstract 1, Title: What neural oscillations reveal about the role of prenatal and postnatal experience in language learning

A hierarchy of embedded neural oscillations is well established as a key neural mechanism underlying speech and language processing in adults (e.g. Giraud & Poeppel 2012; Meyer 2018). Whether this hierarchy emerges in adults as a function of extended experience with language or whether it is part of the neural architecture from the get-go remains unknown. In an EEG study with newborns and 6-month-old infants, we have explored whether neural oscillations are present in infants from birth and how they are modified by pre- and postnatal language experience. We recorded infants' brain activity during speech stimulation, as well as during silence periods before and after stimulation. We presented infants with sentences in their native language, French, as well as in two unfamiliar languages, Spanish, which is rhythmically similar to French, and English, which is rhythmically different from it, and which even newborns are able to discriminate from French (Ramus et al. 2000). We measured infants' brain activity using EEG in 10 frontal, temporal and central electrode sites known to show effects of auditory and speech processing (Winkler et al. 2003). We analyzed the data in three different ways. First, we assessed whether infants' brains entrain to the speech envelope, and found that at birth, entrainment is present for all three languages both in phase and amplitude, while at 6 months, infants' brains track the speech envelope in all three languages for phase, but only in English for amplitude, suggesting that phase and amplitude tracking are different mechanisms, with different developmental trajectories. Phase tracking is a universal, experience independent, possibly basic auditory phenomenon, while amplitude tracking is shaped by language experience. Second, we investigated whether delta, theta and gamma oscillations are already modulated by speech in infants and if so, whether the frequencies of the oscillations are aligned to the rhythms of the native language. We found that newborns show increased activation in the slow, i.e. delta and theta, but not fast, i.e. gamma oscillations to the native language French and the rhythmically similar unknown language Spanish, but not to English, constituting the basis of early rhythmic language discrimination. As this differential response is only observed in the slower oscillatory bands, which coincide with the low frequency information also present in the prenatally heard speech signal, but not in the faster gamma band, we hypothesize that prenatal experience already plays a role in fine-tuning the slower oscillations. Third, we asked whether we can find real-time neural signatures of learning after linguistic stimulation, and found that in the silence periods following French, but not Spanish and English, brain activity showed increased complexity and self-similarity in the long-range temporal correlations, suggesting continued processing and learning even several minutes after stimulation with the native language. Taken together, these results suggest that the architecture of embedded neural oscillations is already present from the start, supporting early speech perception and language acquisition, specifically by delineating linguistic units in the continuous speech signal, such as syllables and phrases, that are useful for word learning and syntax acquisition.

Abstract 2, Title: Phonological Acquisition Depends on the Timing of Features

The infant brain is characterized by slow electrophysiological activity, which limits initial processing abilities to slow information (Menn et al., 2023). Nevertheless, infants start acquiring the phonemes of their native language during their first year of life (e.g., Kuhl, 2007). This is paradoxical, given the short duration of phonemes in speech. We here show that phoneme acquisition hinges on the timing of

phonological features, which for instance specify phoneme class, manner, or place of articulation. While individual phonemes alternate quickly with an average duration of ~50 ms in infant-directed speech (Leong et al., 2015), these features often span sequences of multiple subsequent phonemes, thus fitting infants' slow processing.

We traced the emergence of feature-based phoneme representations that are known to govern speech processing in the mature brain. We collected the electroencephalogram (EEG) from a final sample of 66 children aged 3 months to 4.5 years while they listened to stories in their native (German) and an unfamiliar language (French). Categorical processing of features was assessed using EEG deconvolution encoding models (Temporal Response Functions; Crosse et al., 2016). Deconvolution modelling estimates the average neural response to each feature for each infant while correcting for temporal overlap of phonological features in continuous speech. To account for potential differences in electrophysiological response latencies, our dependent measure was the prediction accuracy of the EEG deconvolution model. High prediction accuracy indicates reliable neural responses to phonological features across the children's story, as is expected once phonological representations have been formed (Di Liberto et al., 2015).

In line with established findings, our cross-sectional analysis uncovers a gradual developmental increase in neural responses to native phonemes (t = 4.87, p < .001), but not non-native phonemes (t = 1.51, p = .133). Native phonological processing took off significantly from a permutation baseline at 14 months. Critically, infants seem to acquire those features first that extend over longer time intervals (t = 2.83, p = .005)—thus meeting infants' slow processing abilities. Shorter-lived phoneme features are added stepwise, with the shortest acquired last. This effect remained significant after controlling for the overall frequency of occurrence of each feature. Post-hoc analyses indicate that a feature's similarity to pitch contours best predicts its age of acquisition (t = 3.42, p < .001), indicating that phonological acquisition may extend upon infants' early proficiency in (electrophysiological) processing of prosody (e.g., Menn et al., 2022).

Our study highlights the role of electrophysiological maturation in shaping early language acquisition. Rather than individual phonemes, longer feature stretches in speech may ideally fit infants' extended temporal receptive windows. The electrophysiological slowness of the infant brain might lead to an initial focus on slowly alternating phonological features at the prosodic rate. Thus, phonological feature acquisition may be analogous to prosodic bootstrapping.

Abstract 3, Title: A Longitudinal Investigation of Cortical Tracking Efficiency in Bilingual Infants: The Influence of Musical Rhythm on Speech Perception

Musical training benefits have been reported in young infants demonstrating enhanced development of prelinguistic communicative gestures, neural processing of temporal structure, and word segmentation. To explain these benefits, it has been proposed that musical stimulation influences cortical tracking efficiency, the mechanism through which brain oscillations synchronize to the acoustic properties of external stimuli. It is still not clear, however, which elements of the music signal are beneficial for language processing. In this study, we focused on teasing apart which elements of the music signal might be involved in these processes. We propose that the phase of brain oscillations resets in response to the rhythm of the musical signal. Hence, the regularity found in the rhythmic structure of music acts as a temporal guide for brain oscillations. Additionally, we tested infants at two ages, 6- and 10-months. Thus,

we explore how the growth of linguistic experience might influence the observed benefits of rhythm exposure on cortical tracking of speech.

This longitudinal study included Basque-Spanish bilingual infants. We took advantage of participants' bilingual experience and assessed the predicted effects on cortical tracking of speech in each of participants' languages across development. We used electroencephalography to record neural responses to musical sequences and spoken sentences when infants were 6 (N=37) and 10 months old (N=31). Infants heard 64 Basque and 64 Spanish sentences produced in natural infant-directed speech. Sentence presentation was preceded either by rhythmically regular musical sequences (regular condition) or by rhythmically irregular musical sequences (irregular condition). The regular sequences were constructed to match the syllabic structure and the melodic contour of the sentences. The irregular sequences were constructed by scrambling note duration and the melodic contour of the regular musical sequences. Only one type of musical sequence and language was used within a single experimental block. Cortical tracking of speech (speech-brain coherence) was calculated as the phase synchronization between the brain signal and the corresponding stimuli envelope weighted by their relative amplitude. Analyses were focused on the delta (~2Hz) and theta (~4Hz) frequency bands and conducted separately for each language.

In the Spanish test, infants showed overall better cortical tracking at 10 months compared to 6 months regardless of the rhythmic condition and across the two frequency bands. In the Basque test, 6-month-old infants showed better cortical tracking in the regular condition compared to the irregular condition in the theta band. In the delta band, there was no difference between rhythmic conditions. At 10 months, we did not find any significant difference between rhythmic conditions in any of the frequencies. Our results demonstrate a rhythm-to-speech benefit in cortical tracking of speech at 6 months in the Basque test. We will discuss how rhythmic auditory stimulation change over early development, and how this might relate to the role of brain oscillations in early speech perception and the maturation of speech processing abilities. Finally, we will discuss how infants' language experience may shape the benefits of rhythm exposure on infants' dominant and non-dominant language perception.

Abstract 4, Title: Synchronizing with the rhythm of speech: infant neural entrainment to speech and musical stimuli

Neural entrainment is defined as the process whereby brain activity, and more specifically neuronal oscillations measured by electroencephalography (EEG), can synchronize with external (exogenous) stimulus rhythms. Low-frequency (< 6 Hz) neural entrainment has been observed for abstract stimulus properties such as the rhythmic patterns of linguistic constituents, and those of musical beats (Nozaradan et al., 2011). Recent theories suggest that individual differences in this phenomenon could be one factor leading to atypical development trajectory of language acquisition (Goswami, 2011). However, despite the importance that neural oscillations have assumed in the last years in the field of auditory neuroscience and speech perception, the oscillatory brain rhythms and their synchronization with complex auditory exogenous stimuli have been relatively unexplored in human infants.

The present study aimed to further investigate infant neural entrainment to continuous stimuli which possess rhythmic patterns; specifically, speech in the form of a rhythmic nursery rhyme (see Figure 1A), and non-speech in the form of a piece of music with matching rate (see Figure 1B). We performed developmental analyses to explore potential similarities and differences between infants' and adults' ability to entrain to the stimuli and we compared infants from general population with a subsample of infants at higher risk of developing language impairment, i.e. infants at familial risk (FH+).

53 8-month-old infants (with and without familial risk for language/learning impairment) have been included in the study. Their EEG signals were recorded while they passively listened to speech and non-speech rhythmic stimuli. The temporal envelope of the rhythm patterns was extracted using a Hilbert function implemented in MATLAB and the Fast Fourier Transform (FFT) was applied to compute the spectrum of acoustic energy. FFT was applied to the averaged EEG using Letswave7 (Mouraux & Iannetti, 2008). Neural entrainment to the incoming rhythms was measured in the form of peaks emerging from the EEG spectrum at frequencies corresponding to the rhythm envelope.

Analyses of the EEG spectrum revealed clear responses above the noise floor at frequencies corresponding to the speech rhythm envelope ($F(1,24) = 6.478$, $p = 0.018$) and to the musical rhythm envelope ($F(1,24) = 21.681$, $p < 0.001$), suggesting that – similarly to adults – FH- infants at 8 months of age are capable of entraining to the incoming complex auditory rhythmic stimuli. Conversely, FH+ infants show similar responses to stimulus envelope and noise in the two conditions ($p > 0.05$), suggesting early anomalies in neural synchronization of both speech and musical rhythms.

Overall, we showed that measures of neural synchronization to complex auditory stimuli are a powerful tool to characterize speech and rhythm perception/synchronization in early (a)typical development. Furthermore, such measures seem appropriate for the investigation of the effect of early music/rhythmic training on early language skills in infancy (e.g., Dondena et al., 2021).

Abstract 5: **Comparing IDS and ADS in production of intonational phrase boundaries**

Introduction: It is essential that infants learn to recognise prosodically demarcated units in continuous speech such as intonational phrases (IPs) because it aids syntactic and lexical development. Most research on IP boundary production in the input focuses on adult-directed speech (ADS). Limited studies comparing and ADS typically only examine the use of prosody at the IP boundary (cf. Geutjes et al. 2023). Consequently, it remains unclear whether IDS differs from ADS in IP boundary production. Against this background, we examined (1) IP boundary production, compared to no boundaries, and (2) relative cue importance in Dutch IDS and ADS.

Hypotheses: Building on previous IP boundary production studies, a greater differentiation in all three types of cues (i.e. lengthening and pitch change in the IP-final syllable, and pause following IP) in IDS than ADS. While Dutch ADS in a lab setting consistently uses final lengthening at IP boundaries (Geutjes et al., 2023), infant research suggests Dutch-learning infants rely on pause (Johnson & Seidl, 2008; Hahn et al., 2020). Thus, we hypothesise varied cue weighting between registers, with final lengthening being most important in ADS and pause in IDS.

Study population: Nine Dutch-speaking mothers and their 4-12-month-old infants participated in this study.

Method: In their homes, mothers saw pictures on a computer screen displaying three girls wearing either identically or differently colored shirts to indicate team membership in a game. They described the teams to their infant seated next to them (IDS condition) and an imaginary adult listener (ADS condition) in counterbalanced orders, using a sequence of names with or without an IP boundary after the 2nd name,e.g. '[Bella en Demi] [en Vera]' (two teams) vs. '[Bella en Demi en Vera]' (one team). The data was annotated in Praat; acoustic measurements were extracted using ProsodyPro.

Results: Linear mixed-effects models indicated that all three cues were used in ADS to mark an IP boundary, but only the pitch and pause cues were used for this purpose in IDS. Moreover, pause was used to a larger extent in IDS than in ADS. In addition, relative weight analysis showed that for both speech registers pause was the most important cue to indicate an IP boundary in Dutch, followed by final lengthening and pitch.

Conclusion: This study has yielded the first evidence that Dutch IDS and ADS differ in the production of IP boundaries, regarding both the types of cues used and the extent to which a cue is used. The similarity between IDS and ADS in the relative importance of individual cues suggests that speakers use the pause cue mostly consistently in both speech registers. Additionally, ADS produced in different settings appear to differ in cue-weighting. Together, these results contribute to a clearer understanding of what constitutes the input relevant to the learning of prosodic phrasing in infancy.

Abstract 6: Is prosodic phrasing gestured to infants?

Introduction: Children learn language through interaction with their caregivers in a multimodal context. Adults modify their speech and gestures when interacting with infants (de Boer, 2011). Infants, in turn, are sensitive to such adaptations in speech perception (Hollich et al., 2005). Despite the multimodal character of infant-adult interaction, little is known on the use of co-speech infant-directed gestures (IDGs) at major prosodic boundaries, such as intonational phrase (IP) boundaries. It remains to be investigated whether co-speech gestures contribute to infants' ability to perceive prosodic phrasing in speech. As a first step toward addressing this question, we investigated in Dutch whether certain types of IDGs consistently co-occur with IPs(i.e. phonological interconnectedness between IPs and gesture types), and when these co-speech gestures occur relative to the beginning and end of an IP (i.e. temporal interconnectedness between IP boundaries and gesture peaks)..

Hypotheses: Based on literature on the IDS-ADS comparison, we hypothesise that IDGs are similar to co-speech adult-directed gestures (ADGs) in phonological interconnectedness i.e. beat and deictic gestures will more likely co-occur with an IP boundary than other types of gestures. Drawing from findings on temporal interconnectedness between IP boundaries and peaks of IDGs in Japanese and English, we hypothesise that hand- and eyebrow-movements will peak relatively closer to the beginning of an IP than to its end in Dutch.

Study population: Nine Dutch-speaking mothers and their 5- to 9-month-old infants took part in the study.

Methods: Live interaction between mothers and their infants were elicited and audio-video recorded in three daily activities: small talk, storytelling, and free play. Data annotation consisted of both manual annotation of hand gestures and automatic annotation of eyebrow gestures using the facial behaviour analysis software OpenFace. We also performed a benchmark analysis to determine whether observable temporal alignment between peaks of hand and eyebrow movements and IP-initial and final boundaries were random. The benchmark analysis entailed checking whether alignment between gesture peaks and IP boundaries would change if the latter ones were shuffled around.

Results: Statistical analysis revealed no evidence for phonological interconnectedness between IP boundaries and gesture types typical of ADGs in Dutch IDGs. Beat, deictic and other gestures were similarly associated with IPs. However, temporal interconnectedness between IP boundaries and gesture

peaks was similar to patterns in IDGs in other languages: IDGs peaked closer to the IP beginning than the IP end.

Conclusions: In infant-directed interaction, there are no specific IDG types that are consistently used at IP boundaries. However, IDGs are consistently anchored with the beginning of an IP. These findings suggest that IDGs may contribute to the learning of prosodic phrasing because of their temporal alignment with the IP beginning.

Abstract 7: **Processing of prosodic phrasing in adult speakers of Dutch**

Introduction: Across languages, speakers use prosodic cues (i.e. lengthening, pitch change and pause) to group words into smaller and potentially meaningful units (prosodic phrasing). However, the relative importance of each cue differs between languages. For example, speakers rely heavily on pitch change in English but final lengthening in German to perceive a major prosodic boundary like an intonational phrase (IP) boundary. Language-learning children thus need to learn language-specific cue-weighting in prosodic phrasing. To determine the developmental goal for Dutch-learning children, we investigated cue-weighting in adult speakers of Dutch by examining the effects of varying combinations of cues on the neurophysiological correlate of boundary processing, i.e. the ERP-component Closure Positive Shift (CPS).

Hypothesis: Based on research on the production of IP boundaries in Dutch ADS in a lab setting (Geutjes et al. 2023), we hypothesise that final lengthening will be the most important cue in the processing of IP boundaries, followed by pause and pitch cues**.** However, based on similar research on Dutch ADS in a home setting (Paper1), we hypothesise that pause will be the most important cue, followed by final lengthening and pitch.

Study population: Thirty adult native speakers of Dutch (mean age: 26y) participated in the experiment.

Methods: Participants listened to sequences of names, connected by the connective *en* ('and'), e.g. *Moni en Lilli en Manu*. These sequences were recorded by a female native speaker of Dutch and acoustically manipulated to create 5 conditions with varying boundary cues: A) no boundary cues, B) pitch rise and final lengthening, C) pitch rise and pause, D) final lengthening and pause, and E) all three cues. ERPs were computed in four scalp regions (frontal and posterior, both left and right).

Results: Linear mixed models were performed on the ERP responses between 500 ms and 800 ms after the onset of the 2nd name's final syllable, following past work on CPS. This showed a significant increase in positivity (CPS) across all regions ($p < 0.001$) when the participants heard all three cues, compared to no cues. Further, the ERPs showed no statistical difference in the absence of the pause cue, compared to no cues. Positive activity increased slightly when the pitch rise was omitted, compared to the all-cue condition ($p < 0.01$). Finally, leaving out the syllable lengthening cue led to no significant differences.

Conclusion: Processing IP boundaries is reflected by CPS in Dutch-speaking adults. The CPS response is absent when the boundaries are not cued by a pause, suggesting a crucial role for pauses in the perception of IP boundaries in Dutch. When a pitch rise is absent, the response is slightly stronger. However, considering the minimal and localised nature of the effect, it is questionable whether it is a consequence of cue weighting. Finally, final lengthening does not alter the CPS-response, indicating that this cue does not contribute significantly to the perception of prosodic boundaries in Dutch. Together, these patterns converge with the cue-weighting in ADS in a home-setting (Paper1).

Abstract 8: **Processing of prosodic phrasing in six-month-old Dutch-learning infants**

Introduction: One crucial skill in language development is the ability to segment speech into smaller, meaningful units. Boundaries between such units (i.e., intonational phrase/IP boundaries) are usually marked by prosodic cues such as pitch change and lengthening of the IP-final syllable and pause. Infants initially rely on all cues but shift their reliance on a subset based on the native language's cue weighting (Seidl & Cristià, 2008; Johnson & Seidl, 2010). English-learning infants detect IP boundaries marked by pitch rise and another cue, aligning with English speakers. German-learning infants process IP boundaries with final lengthening and pitch rise, reflected in the ERP component Closure Positive Shift (CPS), partially mirroring German speakers. In Dutch, cue weighting in ADS in different settings and IDS do not converge (Paper1,Geutjes et al. 2023), while cue weighting in adult processing aligns with IDS (Paper3), highlighting pause's importance. This study examines whether Dutch-learning infants at six months rely on pause for IP boundary perception.

Hypothesis: Assuming that infants' processing reflects input in the IDS, we hypothesise that Dutch-learning 6-month-olds weight pause more importantly than the other cues in their perception of IP boundaries.

Study population: Thirteen Dutch-learning infants (mean age: 6m21days) participated in the study.

Methods: EEG was recorded while the infants were presented with sequences of three names connected by the connective *en* ('and'), similar to Paper3. The stimuli were recorded by a female native speaker of Dutch and manipulated to create 3 conditions: A) without a boundary, B) a boundary cued by pitch rise and final lengthening, and C) a fully marked boundary after the 2nd name. ERPs were computed in four scalp regions (left and right frontal and posterior, LF; RF; LP; RP respectively).

Results: Linear mixed models on the ERP responses between 500 and 800 ms after the onset of the 2nd name's final syllable revealed that the two-cue boundary in comparison to the no-boundary elicited global positivities in the LP and RP regions ($p=0.012$, and $p=0.006$, respectively). The fully-marked boundary resulted in reduced activity in the RP region ($p=0.011$). Exploratory analyses showed that the fully-marked boundary, compared to no-boundary, did not result in significantly more positivity in the LP and RP regions ($p=0.054$ and $p=0.832$, respectively).

Conclusion: Six-month-old Dutch-learning infants showed a CPS to two-cue boundaries in the posterior regions, interpreted as recognition of the IP boundary. A fully-marked boundary resulted in a possible absence of the CPS. These findings suggest that six-month-old Dutch-learning infants do not rely on the pause cue to process IP boundaries. This diverges from IP boundary production in IDS and ADS produced in a home setting (Paper1) and adults' processing pattern (Paper3). A follow-up study focusing on the effect of individual cues on boundary processing, following Paper3, has started and will be finished by July 2024.

S.36 Can we predict childhood executive function from measures in infancy?

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Summary

A central premise of work on global health is that early assessment is critical to supporting abilities like Executive Function (EF) that are predictive of life-long health and well-being. Precisely what to assess, however, is fraught with challenges because we can't directly measure EF in infancy. EF is thought to be comprised of component skills such as working memory and inhibitory control; thus, one approach is to track these components from infancy and ask which skills are predictive of later EF. Presentation one shows that EEG coherence and temperament at 12 months predicted cognitive inhibition and complex response inhibition at 24 months. Presentation two shows that although performance in hot and cool inhibitory control (IC) tasks were associated, there was no evidence of longitudinal stability of IC. Presentation three shows that visual working memory performance measured in infancy was stable over time and predicted EF skills from 30 to 54 months.

Details

Abstract 1, Title: Infancy Predictors of Toddler Inhibitory Control

Abstract 1, text...

Inhibitory control (IC) may be the most critical executive function in early development because it predicts cognitive, academic, and socio-emotional outcomes in childhood and adolescence (Blair & Razza, 2007). Diamond (2013) proposes a view of IC during early development that has two main categories: interference control and self-control/response inhibition. Cognitive inhibition is a subtype of interference control focused on the suppression of previously acquired information and memories. Response inhibition involves resisting temptations and resisting impulsive actions. These types of IC are widely studied in early childhood, but we know little about their development prior to the 2nd birthday. We focused on the development of IC during the second year, when developmental changes in multiple aspects of self-regulation are rapidly occurring. We also wanted to know which intrinsic factors during infancy predict toddler performance on these IC tasks. In adults, both cognitive inhibition and response inhibition are associated with various frontofrontal and frontoparietal networks (Diamond, 2013); thus, we hypothesized that resting state EEG coherence during infancy, as well as infant attention and engagement with the environment (associated with similar brain networks), would predict toddler IC.

Thirty-eight typically developing infants (half girls) and their parents were seen in the research lab at 12 months; we recorded resting-state EEG and calculated coherence between frontal and parietal scalp locations at 6-9 Hz, the frequency band associated with general self-regulation during the first year (Hofstee et al., 2022). Parents completed temperament questionnaires (IBQ-VSF). During the second year, toddlers were seen in the research lab at 15, 18, 21, and 24 months. At each lab visit we administered 3 tasks: cognitive inhibition (looking A-not-B task with invisible displacement; Diamond et al., 1997), simple response inhibition (glitter wand "don't touch" task; Friedman et al., 2012), and complex response inhibition (reverse categorization task; Garon et al., 2008).

For the cognitive inhibition task, performance on the inhibitory trials (reversal or "B" trials) showed development across age (Wilks'= 88, p=.002). The greatest change in development was between 21 and 24 months. Latency to touch on the simple response inhibition task showed development across age (Wilks'=.67, p< 001). As with the cognition inhibition task, the greatest change in development was between 21 and 24 months. A similar pattern of development was seen with the complex response

inhibition task. Next, we examined infant predictors of 24-month performance on each of the IC tasks. Both effortful control and surgency (IBQ-VSF) predicted cognitive inhibition (Rsqr=.05); effortful control predicted complex response inhibition (Rsqr=.04); neither predicted simple response inhibition. Both left and right frontofrontal and frontoparietal EEG coherence predicted cognitive inhibition (Rsqr=.17) and complex response inhibition (Rsqr=.52); EEG did not predict simple response inhibition. We are completing analyses on predictors of trajectory of performance on each task.

These data show development of three different types of IC during the second year and show that parent-report infant attention and engagement and resting state EEG coherence predict 24-month outcomes. This work fills critical gaps in our scientific knowledge regarding normal trajectories of early IC development during toddlerhood.

Abstract 2, Title: A Longitudinal Examination of Hot and Cool Inhibitory Control From Infancy to Early Childhood

Abstract 2, text...

Inhibitory control (IC) enables the exertion of control over our thoughts, actions, and behaviours. When control is exerted in affective contexts it can be labelled as 'hot IC', whereas 'cool IC' refers to control in neutral contexts (Zelazo & Carlson, 2012). Although the first years of life mark an important period for early IC development (Hendry et al., 2016), research has been hindered by the lack of suitable tasks to assess IC in infancy. In this way, the study of longitudinal stability in IC from infancy to early childhood has been limited by the need to use different measures (with differing task demands) across this period.

This pre-registered study investigated concurrent and longitudinal associations between hot and cool IC in the same cohort of participants in infancy (10-months: N = 141, 70% White British, high socio-economic status), toddlerhood (16-months: N = 75), and early childhood (3½ years: N = 93). Hot IC was measured using two prohibition tasks in infancy and toddlerhood (Toy Prohibition; Friedman et al., 2011, and Touchscreen Prohibition; Hendry et al., 2021) and at 3½ years (Dinky Toys, Gift-in-Bag; Kochanska et al., 2000). The Early Childhood Inhibitory Touchscreen Task (ECITT; Holmboe et al., 2021) measured cool IC at all assessment points, and the Go / No-Go task (Howard & Melhuish, 2017), measured cool IC at 3½ years. Based on previous research (Hendry et al., 2021; Holmboe et al., 2021), it was predicted that performance on hot IC tasks would be significantly associated (within-age) at both 10- and 16-months. No specific predictions were made about within-age associations between cool IC tasks at 3½ years, but it was predicted that performance on the two hot IC tasks would be significantly associated. Finally, whilst we would not expect performance on the same task to be significantly correlated from 10- to 16-months, it was expected that individual differences in performance on both hot and cool IC measures would be stable from 16-months to 3½ years.
Performance on hot IC tasks were significantly ($p < .001$) associated (within-age) at all assessment points, and performance on cool IC tasks was significantly ($p = .017$) associated in early childhood. There was no evidence of longitudinal stability of individual differences in hot or cool IC performance from 10- to 16-months, or from infancy to early childhood. Especially where tasks were identical at two or more ages, the lack of stability could not be due to fundamental differences in task design – in particular, performance on the ECITT showed good test-retest reliability at all ages, but no stability between infancy, toddlerhood and early childhood (Fiske et al., 2023). More subtle stability may be detected in larger samples, but we conclude that individual differences in inhibitory control are not set in stone within the first years of life – instead individual children change substantially in their IC skills up until

preschool age.

Abstract 3, Title: Visual working memory performance in infancy predicts executive function abilities from 30 to 54 months of age

Abstract 3, text...

Executive function (EF) is a collection of higher-level skills that integrates component abilities including working memory, cognitive flexibility, and inhibitory control (Miyake et al., 2000). Research suggests that these basic component skills must develop before children can complete complex EF-based tasks in childhood (Devine et al., 2019). A central question is, therefore, whether early developing component skills predict EF abilities later in childhood. This is important as EF improves dramatically from 3 to 5 years (Buss & Spencer, 2014; Carlson, 2005; Diamond, 2013, Garon et al., 2008) and is strongly correlated with academic achievement (Alloway, Banner, & Smith, 2011; Blair & Razza, 2007).

Our study focuses on the early development of visual working memory (VWM). VWM can be measured in infancy and is predictive of later cognitive abilities, with individual differences in visual cognition tasks predicting child outcomes up to 11 years later (Rose Feldman, & Jankowski, 2012). Examining VWM allows us to study young infants using eye-tracking tasks that do not require language. Here we asked whether VWM in infancy predicts later EF development.

Two cohorts were assessed longitudinally: 64 infants (31 girls) were examined at 6-, 18-, and 30 months; 85 children (44 girls) were examined at 30, 42, and 54 months. Both cohorts completed a VWM preferential looking task at all assessment points (see Ross-Sheehy et al., 2003; Wijeakumar et al., 2019). This task used two displays with colourful blinking squares. On one side, one square changed colour after each ‘blink’; on the other, the colours remained the same. Children also completed the Minnesota executive function scale (MEFS; Carlson & Zelazo, 2014). The 6mo cohort completed this task at 30 months; the 30mo cohort completed this task at all ages.

Results from the 6mo cohort show that looking behaviours in the VWM task from 6 to 30 months were predictive longitudinally. In addition, greater looking to the changing side at 6 months was associated with better EF outcomes, particularly for infants with lower educated mothers (Figure 1, blue lines). For infants with a higher educated mother and a lower proportion of looking to the changing side at 18 months (left panel), we found that greater looking to the changing side at 6 months was related to stronger EF skills at 30 months. For infants with a higher educated mother and a higher proportion of looking to the changing side at 18 months (right panel), infants had better EF outcomes with weaker relationships with looking scores at 6 months.

Results from the 30mo cohort show looking behaviours on the VWM task at 30 months are predictive of EF performance at 42 and 54 months of age. Here, the predictive nature of VWM is once again influenced by maternal education. We found a higher proportion of looking to the changing side at 30 months predicted higher EF at 42 and 54 months, particularly for infants with a lower educated mother (Figure 2).

In summary, VWM in infancy robustly predicts EF from 30 to 54 months of age.

S.37 Born during the COVID-19 pandemic: brain development and infant functional outcomes

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Summary

The COVID-19 pandemic brought significant stress for families with infants. Pregnant people were disproportionately affected by pandemic-related stressors, with changes to perinatal care, reduced access to supports, and fears about maternal and neonatal illness. In turn, babies born during the pandemic may be at elevated risk for altered brain development and outcome.

This symposium will feature novel recent behavioural and neuroimaging research in fetuses, neonates and young children who were born during the pandemic. We will present recent findings from cross-sectional and longitudinal cohorts in children that were born during the pandemic demonstrating difficulties with language, cognitive and motor function.

Research findings will be discussed in relation to individual differences and potential risk/resilience factors, which will provide the basis to inform future therapeutic interventions to mitigate the adverse effects of pandemic-related stressors on child brain development.

Details

Abstract 1 COVID-19 pandemic: Antenatal maternal distress, newborn hippocampal development and cognitive ability

Background: The COVID-19 pandemic led to widespread impacts on daily life. Pregnant women may have been disproportionately affected by the stressors associated with the lockdowns including lack of access to obstetric care, and fears related to the virus concerning their own health and the health of their newborn. Previous evidence suggests that exposure to maternal disaster-related stress is associated with delayed brain development in infants and may be a risk factor for altered cognitive performance. A key mechanism may be related to alterations in dopaminergic processing in the hippocampal - ventral tegmental area (VTA) loop, that mediates long-term memory function.

Objectives: To characterize hippocampal development using magnetic resonance imaging (MRI), hippocampal-VTA functioning using neuromelanin (NM) MRI, in relation to cognitive outcomes in newborns exposed to high levels of antenatal distress.

Methods: Thirty-five women with singleton pregnancies were recruited in their third trimester as part of a longitudinal imaging study. Mothers completed the Perceived Stress Scale at two timepoints, at least 2 weeks apart. Families returned for newborn (2-5 months) magnetic resonance imaging (MRI) scan. Newborns (n=35, 19 males) completed a T1-weighted structural MRI scan as well as a NM-MRI scan using a three-dimensional gradient recalled echo sequence with magnetization transfer (MT) contrast (~5 minutes) on a 3T Prisma fit MRI scanner (Siemens, Erlangen, Germany). Hippocampal volumes were automatically extracted. NM contrast to noise ratios for the substantia nigra-VTA area relative the cerebral peduncles were manually extracted. To assess developmental abilities, mothers completed the

Ages and Stages Questionnaire, 3rd edition (ASQ-3) and the problem-solving subscale was used to assess early cognitive processes.

Results: Mothers' levels of perceived stress during the third trimester of pregnancy were in the elevated range (timepoint 1: M=14.83, SD=7.8; timepoint 2: M=15.42, SD=6.73) and remained unchanged between the two timepoints (p=0.14). Infants mean problem solving skills on the ASQ-3 were below average (<35, M=33.31, SD=14.74). Based on an interaction analysis, newborns who performed poorly on the problem solving subscale had smaller hippocampal volumes and increased SN-VTA signal compared to newborns who performed well, who had larger hippocampal volumes and lower signal in the SN-VTA (p=0.012).

Discussion: Findings indicate that dysregulated processing in the hippocampal-VTA loop coupled with dysmaturation of the hippocampus may underlie cognitive impairments in newborns exposed to high level of antenatal distress.

Abstract 2 Language learning in the context of a global pandemic: Proximal and distal factors matter

Introduction: The COVID-19 pandemic disrupted the prenatal and early life development context for children worldwide. Inspired by Bronfenbrenner's ecological systems theory, we postulated that pervasive and ubiquitous disruptions resulting from the pandemic would occur at multiple levels of analysis. Here we focus on 'late talkers'; toddlers between 18 and 35 months of age who, in the absence of medical reasons, fall ≤ the 10th percentile for number of words in their expressive vocabulary.

Objectives: 1) Determine whether the prevalence of late talkers among toddlers born during the pandemic was increased relative to normative data. 2) Determine which features of the prenatal and early life environment may be associated with changes in the prevalence of late talkers during the pandemic.

Participants: Participants were recruited to the longitudinal Pregnancy during the Pandemic (PdP) cohort study through advertising on social media between April 2020 and April 2021. Pregnant individuals were eligible if they were ≤35 weeks of gestation, ≥17 years-old, living in Canada, and able to read and write in English. Although the sample contains a diverse range of sociodemographic characteristics, most participants had education beyond high school, had stable income, and were White.

Methods: Questionnaires administered at study enrollment (during pregnancy) assessed sociodemographic characteristics and pandemic-related objective hardship. Postnatal parental psychological distress was assessed at 3, 6, 12, and 24 months. Child expressive vocabulary (MacArthur-Bates Communicative Development Inventories; CDI-III) was obtained from 4044 participants at 24 months postpartum (range 23 to 26 months). Public health measures during the period from the infant's DOB to their 2-year birthday was calculated using the Oxford COVID-19 Government Response Tracker (OxCGRT).

Results: Using general (combined sex) norms, the proportion of toddlers at or below the 10th percentile was 10.7%, which is not different from the norming sample, z=0.54, p=.45. To assess for sex differences, we stratified by sex and compared toddlers to sex-specific norms. The prevalence of late talking was 16.5% among female toddlers, which was significantly different from the norming sample, z=8.61,

p<0.0001. In contrast, the prevalence of late talking among male toddlers was 9.3%, which was not different from the norming sample, z=0.95, p=0.34.

A hierarchical logistic regression was used to identify factors at different levels of Bronfenbrenner's theory associated with expressive vocabulary (Table 1). At the most proximal level, being male and lower socioeconomic status were associated with increased odds for being a late talker. In the middle levels, childcare outside the home was a protective factor while disruptions to childcare increased the odds for being a late talker. At the most distal level, exposure to greater pandemic-related public health measures were associated with increased odds for being a late talker. The complete model explained ~8.5% of the variance in being a late talker.

Discussion: The findings suggest that the pandemic may have differentially affected female infants, who had increased odds of being a late talker relative to females prior to the pandemic. Overall, the findings suggest that vocabulary acquisition was not substantially affected by the pandemic.

Abstract 3 The COVID-19 Pandemic and Early Child Cognitive Development: A Comparison of Development in Children Born During the Pandemic and Historical References

The outbreak of the SARS-CoV-2 (COVID-19) pandemic brought widespread disruption to our social, economic, and public health environments. While children were largely spared the severe health and mortality complications of SARS-CoV-2 infection, they were not immune to the impact of the public health policies that closed daycares, schools, and playgrounds. While these policies helped limit COVID-19 spread, they also limited interaction with other children and caregivers, and reduced opportunities for physical activity and play, the cognitive and developmental impact of which were unknown but are now beginning to emerge.

To assess the impact of the COVID-19 pandemic environment on child neurodevelopment, longitudinal neurocognitive data (Mullen Scales of Early Learning, MSEL) were drawn from 700 healthy and neurotypically-developing children, 0-5 years of age, between 2011 to 2021 without reported positive tests or clinical diagnosis of SARS-CoV-2 infection. All data, including those collected during the early pandemic period (Dec 2020 - June 2021) that corresponded to the main period of daycare closures and shelter-in-place and work-from-home orders, were collected in-person. During the COVID period, masks and other mandated protective measures were observed.

Using these data, we examined temporal trends in MSEL composite measures (general cognition, verbal, and non-verbal development, ELC, VDQ, and NVDQ, respectively) to determine if child assessments measured during 2020 and 2021 differed significantly from historical 2011-2019 data ranges. We also compared MSEL values in a sub-cohort comprising infants 0-16 months of age born during the pandemic vs. infants born prior. In all analyses, we also included measures of socioeconomic status, birth outcome history, and maternal stress.

We observed a significant decrease in mean overall population MSEL measures in children 0-5 years of age in 2021 compared to historical references of 24.6 points (p<0.0001), Fig. 1a.

Focussing on infants born before and during the pandemic (Fig. 1b), we found similar reductions in performance in 2021 (mean ELC, VDQ, and NVDQ scores of 83.1+/-14.1, 75.5+/-24.1, and 91.1+/-24.1

compared to historical ranges from 95 to 107, Fig. 1b. Effect sizes (Cohen's f^2) for significant differences ranged from small (0.05) to large (0.4).

Maternal stress was not found to be associated with observed declines but a higher socioeconomic status was found to be protective.

These results reveal a striking decline in cognitive performance exhibited across children since the onset of the COVID-19 pandemic. This effect is particularly pronounced in infants, with those born since mid-2020 showing an average decrease of 27-37 points.

Abstract 4 Infant motor milestone achievement in the context of In Utero Exposure to the COVID-19

Background: The COVID-19 pandemic represents an unprecedented stressor for pregnant people, yet the effects of *in utero* exposure to the pandemic on infant motor development remain little investigated. Previous research conducted with rodents and non-human primates suggest that exposure to stressful situations during pregnancy is associated with impaired motor development, though human studies are more equivocal (Buitelaar et al., 2003). The goal of the current study was to examine whether *in utero* exposure to the COVID-19 pandemic (both the chronicity of *in utero* exposure, and the severity of pregnant person psychological distress) is associated with infant gross and fine motor development.

Child sex is commonly hypothesized to moderate prenatal effects (DiPietro & Voegtline, 2017), though the nature of this moderation may depend on the chronicity of exposure to the event and to the severity of the symptoms experienced by the birthing parent. Female and male fetuses grow at different rates, their placentas function differently, and their amniotic fluid has different hormonal composition (DiPietro & Voegtline, 2017). Though males are often described as being more vulnerable to *in utero* insults, it has been argued that when male fetuses survive, they are more robust to later environmental risk exposures (Sandman et al., 2013). Whether child sex moderates effects of the COVID-19 pandemic on infant motor development remains unknown.

Method: Participants (N=525) were pregnant and early postpartum individuals and their children receiving care through an academic medical center in Portland, Oregon. Birthing parents were 88% White, 9% Latina; on average 33.57 years old (range=18.49-49 years); the median household income was $100-120,000 (range:<$10,000-$250,000+).

Participants completed the COPE-Impact Survey (Thomason, Graham, & VanTieghem, 2020) at enrollment; the COVID-related distress composite score was used as a measure of severity of psychological distress. The length of *in utero* exposure (the percentage of the pregnancy after 3/11/2020), and was used to capture the chronicity of child exposure. Child gross and fine motor development was assessed using the Ages and Stages Questionnaire 3rd Edition (ASQ-3) at 12 months of age.

Hypotheses were tested using multiple regression using the M*plus* software (Muthen & Muthen, 1998-2017). FIML was used to accommodate missing data.

Results: More chronic *in utero* exposure was associated with lower gross motor scores (β=-.245, *p* <.001). The length of *in utero* exposure was also associated with lower fine motor scores (β=-.254,

p<.001), however this effect was moderated by child sex (Fig. 1), such that more chronic exposure to the pandemic was associated with lower fine motor scores among male children only (slope=-5.89 *p*=.02).

Greater COVID-related distress was also associated with lower gross motor scores (β=-.19, *p*=.01), however this effect was moderated by child sex (Fig. 2), such that more severe distress was associated with lower gross motor scores for female children only (slope=-10.86, *p*<.001). COVID-related distress was not associated with fine motor scores.

Discussion: Results suggest that infant motor milestone achievement is compromised in the context of the COVID-19 pandemic and confirm that the nature of sex-specific *in utero* effects depend on the chronicity and severity of the exposure.

S.38 Brain correlates of neurodevelopment in neurotypical and clinical populations

Sarah Lippé [1], **Emily Jones** [2], **Saeideh Davoudi** [1], **Lauren Emberson** [3], **Jannath Begum Ali** [4], **Elizabeth Smith** [5]

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Summary

The brain signals have been shown to be extremely sensitive to brain maturation, as well as sensitive to clinical conditions in the first years of life. This symposium proposes new methods to address brain maturation and alterations in clinical conditions. The first presentation will propose a methodological EEG pipeline to assess the brain age gap. The second presentation will portray the brain signals of premature infants while learning from associations and producing prediction. The third presentation will demonstrate the early alterations in the EEG and NIRS signals of infants presenting a Fragile X Syndrome. The last presentation will show how the EEG signal of infants presenting Neurofibromatosis type 1, a condition frequently comorbid with ADHD and ASD, differ from infants at high likelihood of presenting ASD and ADHD. The discussion will address how new methodologies can accelerate the characterization of the brain signals in infants and their translation into a clinical tool.

Details

Abstract 1: Title: Predicting EEG-based biological age in infants: a machine learning and deep learning approach

Authors: Saeideh Davoudi, Florence Deguire, Gabriela Lopez, Janet Werker, Laurel Trainor, Sarah Lippé

The discrepancy between chronological and biological age of an individual's brain which is so-called brain age gap (BAG) is a marker of accelerated/decelerated biological brain aging. BAG is extensively estimated using structural MRI and machine learning (ML) or deep learning (DL) techniques. Brain age prediction and BAG estimation incorporating Electroencephalography (EEG) have been insufficiently noticed. Even in few EEG studies in this area, their high performance has dependency on long-duration recording of EEG and often during sleep which is not well-suited for clinical monitoring or in specific

populations like infants. On the other hand, MRI is expensive and requires infrastructure requirements which are difficult to justify for the universal needs particularly for infants. Hence the significance of employing short-time recording EEG in BAG concept is more highlighted. We used one-minutes resting-state eye-open EEG recorded from 217 infants with the age range of 3-14 months (mean=7.6±2.5 std). Using two approaches; ML and DL, we aimed to accurately predict the biological brain age and estimate BAG in infants up to 14-months-old. For ML arm of the study, a wide range of linear and non-linear features were extracted and used in combination of traditional regression models (support vector regression, linear regression, and random forest regression) and for DL arm, raw EEG data of each infant was inputted to the time-series DL models (TST, TSTplus, InceptionTime, XceptionTime). The performance of the models was quantified by R-squared, RMSE (in month), MAE (in month), and the correlation between chronological and biological age (r). The results of ML regression models with using univariate feature ranking for regression using F-tests method showed that the linear regression yielded the best performance with R-squared=0.72, RMSE=1.1, MSE=0.93, r=0.85 (pvalue=1.5×10^{-12}). Interestingly, when gender was added as a controlling variable to the regression model, the performance improved which results in R2, MAE, RMSE, and r equal to 0.77, 1, 0.85, and 0.88 (pvalue=3.77×10^{-19}), respectively proving the effect of sex difference on brain age in the first year of life. The model used only nine features, mostly including those measures which reflect the complexity and non-linearity nature of the brain. The best performance of the DL regression models was yielded by InceptionTime model and learning rate of 0.1 with 100 training epochs which results in R-squared=0.83, RMSE=0.98, MSE=0.83, r=0.91 (pvalue= 2.5×10^{-86}). Our results from ML depicted that in the even in the first year of life, brain follows the pattern of increased non-linearity and complexity since these features could best fit the chronological age. EEG is a powerful tool to reflect functional brain development as the DL performance showed even raw EEG time-series have valuable information to predict age. Since we could gain this state-of-art performance with only 1-minutes of EEG, we hope this framework can be extended to apply in task-related EEG and in pediatric population to capture any deviation from natural aging in neurodevelopmental disorders.

Abstract 2: Title: Examining neural activity during prediction and learning reveals key differences between infants born full-term and infants born very and extremely prematurely. Authors: Lauren L. Emberson, Julie Riccio, Ronnie Guillet, Richard Aslin, Alex Boldin, Sagi Jaffe-Dax.

Abstract 2. Text: While it has long been established that infants are excellent learners, rapidly and effectively picking up on patterns in their environment. Recent research has shown that in addition to being sensitive to these patterns, human infants are able to use this recently learned information to predict upcoming sensory information and modulate their perceptual processing. Theoretical accounts have also suggested that learning and prediction may be important mechanisms by which the developing brain becomes specialized to the infant's environment. Are these key mechanisms altered in young infants who are at higher likelihood of experiencing developmental challenges and needing early intervention? One such group are infants born very and extremely prematurely (<33 weeks gestation). Infants born prematurely have a higher likelihood of experiences challenges in many aspects of their development including language and motor development. They are at higher likelihood of experiencing learning disabilities at school. This pattern of risk is present even when infants born prematurely have few or no medical complications during their treatment in the Neonatal Intensive Care Unit (NICU). This talk will present on a series of studies examining the pattern of neural activity in perceptual systems (visual and auditory) and the prefrontal cortex of infants born very and extremely prematurely (< 33 weeks gestation) compared to infants born at full-term during audiovisual associative learning and prediction of upcoming sensory information. Both groups were tested at 6 months of age (corrected age

for premature infants). Infants born prematurely were screened for significant medical complications to be outlined in detail in the talk. Overall, the studies reveal both important similarities between these groups but also key differences. Importantly, much more richness in the similarities and differences was revealed through the use of neuroimaging compared to behavioural measures. For example, a behavioural measure of audiovisual learning, using the standard looking time measures, was equal across groups with infants born prematurely showing significant differences in looking between familiar and novel trials. However, a study examining a key and already established neural signature of top-down sensory prediction revealed striking differences between infants born prematurely and infants born full-term. Specifically, infants born prematurely do not exhibit evidence of predictive changes related to learning in their visual system (occipital lobe). Novel analyses using mixed effect modelling revealed that some regions of the brain in infants born prematurely show evidence of learning related modulation (prefrontal cortex, auditory system) but some do not (visual system) while infants born full-term show evidence of learning related modulation in all regions. Finally, an analysis using parameters of a computational learning model (Resorla-Wagner Model) regressed against the neural data revealed that the prefrontal cortex in both groups shows significant sensitivity to the prediction errors related to the learning task again suggesting similarities in associative learning across groups but differences in whether this information is communicated to the visual system.

Abstract 3: Title: Neural signatures of communicative impairment and altered speech perception in Fragile X Syndrome. Authors: Elizabeth Smith, PhD (Division of Behavioral Medicine and Clinical Psychology, Cincinnati Children's Hospital, Shelby Hatton, B.S. (Department of Neuroscience, University of Cincinnati, Lisa DeStefano, PhD (Division of Psychiatry, Cincinnati Children's Hospital, Craig Erickson, MD (Division of Psychiatry, Cincinnati Children's Hospital.

Abstract 3: Text: Fragile X Syndrome (FXS) is a genetic condition resulting from a trinucleotide (CGG) repeat expansion on the X chromosome that is associated with early emerging delays in cognition and language as well as increased risk for autism spectrum disorder. Electroencephalography (EEG) has been used extensively to characterize neural activity in the mouse model of FXS and in adult humans with FXS, with the following features differentiating FXS from typically developing controls (TDC): 1) increased resting power in the theta and gamma ranges[1, 2], 2) a downward shift in individual alpha peak frequencies [3, 4] and 3) differences in event related potentials (ERPs) and event related power in response to auditory stimuli [5, 6]. Here, we present early findings (total n=20 0-5 year olds) that extend this work into children and especially infants with FXS, use multimodal EEG and functional Near Infrared Spectroscopy (fNIRS) to further define altered neural patterns, and relate this neural signature to emergence of early delays in language and communication. We hypothesize that EEG features present in adults with FXS will be present in children and infants with FXS, that they will be associated with altered hemodynamic activity during auditory processing, and that these features will be associated with early language impairments. We present preliminary data from two samples. Study 1 investigates hemodynamic changes during speech and nonspeech perception across 20 channels in bilateral auditory cortex across 20 in 0-5 year olds with FXS and TDC. Study 2 uses simultaneous, event-related fNIRS and EEG in FXS and TDC infants ages 6-36 months. For study 2, infants were followed longitudinally, and completed fNIRS/EEG (with 12 fNIRS channels and 32 channel EEG integrated in an elastic cap) during speech and non-speech perception as well as cognitive, language, and audiologic evaluation at all visits. Study 1 results show an increased neural response to speech shaped noise in the left auditory cortex in 7 children with FXS compared with 5 TDC children ($t(12)=-2.04$, $p=.04$), which is consistent with heightened amplitudes of auditory ERP's in adults with FXS. Study 2 extends this finding in infants with FXS, showing increased neural activity in bilateral auditory cortex in FXS to speech shaped noise

alongside significant differences in event-related power by group for the three conditions. Specifically, theta/alpha power across 32 channels in 3 TDC infants varied during presentation of speech, low-pass filtered speech, and noise ($p<.001$) whereas infants with FXS (n=5) did not show a differential response in alpha power. Potential mechanisms relating the two neural patterns will be discussed, and longitudinal relation to language outcomes and potential mechanisms of developmental impairment will be examined.

Abstract 4: Title: Theta-beta ratios are altered in infants with a family history of Autism Spectrum Disorder and/or Attention Deficit Hyperactivity Disorder, but not in infants with Neurofibromatosis Type 1. Authors: Jannath Begum Ali, Amy Goodwin, Luke Mason, Shruti Garg, Jonathan Green, Tony Charman, Mark H. Johnson & Emily J.H. Jones and the STAARS and EDEN Teams.

Abstract 4. Text: Background: Neurodevelopmental disorders such as Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD) are typically diagnosed in early/middle childhood through a combination of clinical interviews and observer-reports. The genetic factors that predispose an individual towards these highly heritable conditions likely act predominately prenatally, affecting brain development for years before the consolidation of the full clinical phenotype (Faraone & Larsson, 2019). Identifying the brain changes that precede the onset of behavioral symptoms could help with earlier identification of individuals who require additional support, and could provide useful outcome measures for early interventions. One such neural change is the balance of theta and higher frequency oscillations (typically theta-beta ratio; TBR). Previous research has shown that a subset of children with ADHD show differences in TBR and its use as a prognostic indicator has been suggested (Arns et al., 2013), whilst prospective longitudinal research has demonstrated altered TBR in 10-month-olds with a family history of ADHD (Begum Ali, Goodwin et al., 2022). Objectives: We endeavoured to examine TBR using a prospective longitudinal infant sibling design. We examined infants with an elevated likelihood of developing ASD, ADHD, ASD+ADHD or neither and also those infants diagnosed with a genetic disorder that has been linked with increased likelihood of ASD and/or ADHD; Neurofibromatosis Type 1 (NF1). Methods: We used high density EEG (128-channels) to investigate the theta/beta ratio in 14-month-old infants; with theta defined as 2-5Hz and beta defined as 9-14Hz. Results: We found reduced TBR infants with an elevated likelihood of ASD [$F(1, 108) = 5.54$, $p = .02$] or an elevated likelihood of ADHD [$F(1, 108) = 3.97$, $p = .05$]. Lower TBR was driven by lower theta [ASD-L: $F(1,108) = 6.57$, $p = .01$; ADHD-L: $F(1, 108) = 4.77$, $p = .03$] and higher beta in infants at elevated likelihood of ASD [$F(1,108) = 6.36$, $p = .01$] or ADHD-L, though this was at a marginally significant level [$F(1, 108) = 3.6$, $p = .06$]. We found no significant differences in TBR between our NF1 and typical likelihood group [$F(1, 35) = .27$, $p = .61$; see Figure 1]. Conclusions: This is the first demonstration that alterations in TBR are present in infants with a family history of ASD, extending the findings of Begum Ali, Goodwin et al. (2022), who found differences in TBR only in infants with an elevated likelihood of ADHD. Interestingly, our NF1 cohort showed no alterations in TBR. We will discuss the developmental trajectories of TBR alterations and the implications for each neurodevelopmental condition.

S.39 Visual Traces on Audiovisual Speech in the First Two Years of Life: Towards a Converging Developmental Picture

Charlotte Viktorsson [1], **Teodora Gliga** [2], **Magdalena Szmytke** [3], **Itziar Lozano Sánchez** [3], **Elena Capelli** [4]

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Summary

Decades of eye-tracking research highlight the importance of infants efficiently learning to “look at speech” for language acquisition. However, the developmental picture of selective attention to audiovisual speech lacks convergence, posing challenges discussed in this symposium. In Talk 1, we address the issue of what drives changes in mouth-looking in the first year: it is specifically visual speech, not a broader interest in mouth movements. In Talk 2, we delve into the problem of measuring mouth-looking beyond infancy as a language-supporting mechanism, proposing a more sensitive multimethod approach. In Talk 3, we tackle whether audiovisual speech processing and attention to talking faces are linked by studying atypically developing infants longitudinally, finding they indeed intertwine. Our findings reveal that mouth-looking’s trajectory, especially by year-end, is tied to visual speech and linked to the perceptual domain, bridging developmental gaps for a more unified view.

Details

Abstract 1, Title: Movement as attention driver? Visual attention to faces while watching visemes and gurning in 5- and 10-month-old infants.

Infants acquire speech through various modalities, including somatosensory, visual, and auditory cues. They can distinguish between native and foreign languages based solely on visual cues (Weikum et al., 2007), suggesting mouth movements are a valuable source for speech recognition. The change in visual attention in infants is well-documented. Up to the age of 6 months, infants primarily focus on the eyes, while in the second half of the first year of life, their attention shifts to the mouth (Lewkowicz & Hansen-Tift, 2012; Tomalski et al., 2013; Mercure et al., 2019; Morin-Lessard et al., 2019). This attentional shift towards the mouth is assumed to result from a growing interest in visual speech, facilitating language learning. However, whether this enhanced focus on the mouth in the second part of the first year of life is a result of increased visual speech interest remains unclear. Alternatively, it could also reflect a more general developmental tendency to pay attention to moving mouth.

One way to evaluate the specificity of attention to any mouth movement versus visual speech is to employ non-communicative mouth movements, such as gurning. While these stimuli have been applied in neuroimaging research (Bernstein, 2011, Dopierała et al., 2023), they have not yet been used in behavioral studies with infants. In this study, we use this event as a novel approach to address this question.

We tested infants' visual attention while watching visemes (visual speech) and non-communicative mouth movements in two age groups: before (6-month-olds, n=33) and during (10-month-olds, n=36) the period that infants begin to produce syllables. The experiment involved two types of soundless stimuli (speech and gurning), presented in a pseudorandom order. Infants watched eight short clips presented by two actresses, each pronouncing two syllables and presenting gurning movements. Infants' looking behavior was recorded using the *Tobii T60 XL*. The proportion of total looking time towards defined areas of interest (mouth vs. eyes) was computed for each condition separately.

In line with previous results, we also show here that infants at 10 months of age looked more at the mouth than the eyes area (p<.001), whereas 6-month-olds did not spend more time on the mouth area in comparison to the eyes (p=.571). Further planned comparison of the proportion of looking to the mouth showed that the older group of infants looked significantly longer at the mouth in speech condition

compared to gurning ($F_{(1,35)}$=4.564, p=.04, η^2=.115); there were no differences in mouth looking in the younger group (p=.28).

The obtained results replicate previous studies showing that older infants look longer at the mouth when processing faces. Moreover, the reported shift seems to be more than just a general tendency toward mouth movement, as 10-month-olds looked longer at the mouth when observing mouth pronouncing syllables than gurning. The extended looking time at the speech condition suggests that infants' developmental tendency to look more at the mouth is speech-specific and may aid language learning.

Study was pre-registered: https://osf.io/d8j92/?view_only=a31450f4688f41058f868e2cb43e7803 ;

Abstract 2, Title: The Role of Mouth-looking in Word Learning in Toddlerhood: An EEG and Eye-tracking Study.

Infants' learning to attend to talking faces is foundational to their early language acquisition. Increased mouth-looking across infancy benefits vocabulary skills at the end of the first year of life (Belteki et al., 2022). Whether mouth-looking remains a language-supportive mechanism also over toddlerhood is unknown. During the second year of life, mouth-looking is assumed to reflect toddlers entering the word-acquisition phase. However, the only study published so far found no association between mouth-looking and productive vocabulary in 14–18-month-olds (Hillairet de Boisferon et al., 2018). To date, the approach taken to study this relationship has been to explore associations between preference for the mouth in eye-tracking tasks and parental vocabulary reports. However, the potential link between toddlers' attention to the mouth and their direct performance in word acquisition remains unexplored. A more *direct* approach using alternative finer-grained methods which might be more sensitive to this potential relationship is needed.

One way to directly assess toddlers' proficiency in the word learning process is to measure neural indices underlying this ability. The N400 ERP component is a neural indicator that directly measures proficiency in semantic integration, a key mechanism of word learning that develops through toddlerhood (Junge et al., 2021). If a semantically incongruent picture-word pair evokes a more negative amplitude of the N400 than a congruent one, this indicates semantic integration. In toddlers with larger vocabularies, the N400 effect occurs earlier in development and with an earlier latency (Rämä et al., 2013). This makes the N400 a neural correlate that reflects proficiency in word acquisition.

This study uses a multimethod approach to explore within-individuals' associations between attention to the mouth in audiovisual speech events and word learning during the second year of life. We used a semantic priming paradigm (congruent and incongruent picture-word trials) while recording the EEG signal, and a free-viewing eye-tracking task of selective attention to audiovisual speech. Given that language familiarity drives mouth-looking in infancy (Lewkowicz et al., 2012), we presented toddlers with trials of a familiar vs. an unfamiliar language to test potential language-specific associations.

We predict that toddlers with a higher preference for the mouth of a talking face (measured by the proportion of total looking time) will show higher proficiency in a semantic priming paradigm (indicated by more robust N400 effects). We expect to observe this association already in 18-month-olds, with a tendency to be more robust in 24-month-olds. Furthermore, we expect the association to be present in the familiar condition only, thus suggesting language-specific effects.

In a cross-labs collaboration, we have thus far tested 85 monolingual Polish and Norwegian 18- (*n* = 46) and 24-month-olds (*n* = 39) cross-sectionally. Correlations between the proportion of total looking time to the mouth and the robustness of N400 effect (differential amplitude) by age-group and language will be conducted. We will analyze our data after pre-registration (ongoing) and after completing the planned sample size (final *N* = 100). The results of our multi-method study will provide new insights into the role that mouth-looking plays in language development in toddlerhood.;

Abstract 3, Title: Developmental Pathways of Audiovisual Processing in Infants at Elevated Likelihood of Autism During the First Year of Life.

Sensory processing refers to how we perceive, process, filter, and react to sensory stimuli in the environment. Atypical sensory reactivity is now considered a diagnostic criterion of autism spectrum disorder (ASD) under the heading of restricted and repetitive behaviors, according to the DSM-5 (APA, 2013). Autistic individuals perform poorly during conditions that require integration across multiple sensory modalities such as audiovisual (AV) integration. However, longitudinal studies of AV speech integration in the first year of life using experimental techniques are still scarce.

The main goals of this study are: (1) to track developmental trajectories of AV integration skills at 6, 9, and 12 months in infants at elevated likelihood of developing autism (EL-ASD) and typically developing (TD) infants; (2) to characterize specific looking patterns to facial features of talking faces (eyes and mouth) in the two groups; and (3) to assess associations between early AV skills and the clinical measure of infant neurodevelopment.

This research is part of a larger longitudinal study on EL-ASD infant siblings. At age 6, 9, and 12 months, AV integration skills in EL-ASD (n = 51) and TD infants (n = 59) were characterized in an eye-tracking preferential looking paradigm measuring the McGurk effect (see Figure 1). Infants' looking behavior was recorded using the Tobii ProSpectrum 300Hz. The proportion of total looking time for congruent/incongruent faces and towards specific areas of interest (mouth vs eyes) were computed for each condition.

The results showed no significant differences between groups for congruent and incongruent stimuli and the two groups showed similar looking time for both faces (see Figure 2a).

Taking into account the looking time toward the mouth area of interest (mouth/mouth+eyes), the results showed a main effect of Time-Point and a main effect of Group. In both groups, looking behavior toward the mouth increased during development (from 6 to 12 months), and this pattern is stronger in TD infants (see Figure 2b). In addition, a significant Condition X Time-Point X Group interaction was found. At 6 months, TD and EL-ASD groups showed different gaze patterns when watching incongruent videos, when auditory and visual stimuli cannot be integrated into a fusible percept and when the percept violates permissible phonetic rules of the infant's mother tongue.

This study is ongoing and clinical measures at 24 months will be available for all infants.

Future work should continue to investigate individual variability as well as group differences in AV speech processing, potentially distinguishing between infants who later develop autism and those who do not receive a diagnosis. These findings may allow researchers to better understand (a)typical

trajectories in autism and clinical implications in the development of more individualized and specific supports.

S.40 Advancing Translational Science of Nurturing Caregiving to Improve Infant Outcomes

Kathleen Baggett [1], **Edward Feil** [2], **Monica Oxford** [3], **Daniel Whitaker** [4]

[1] Georgia State Universtiy, [2] Oregon Research Institute, [3] University of Washington, [4] Georgia State University

Summary

Nurturing relationships with parental caregivers are the cornerstone of infant well-being. When infant adverse experience exposure occurs, it often does so within the context of compromised caregiving. We report results of three studies employing innovative interventions focused on nurturing caregiver relationships with uniquely diverse, high-need infant populations: (1) minoritized dyads in which mothers were depressed and experiencing financial hardship, (2) reunifying birth parents whose infants had been placed in foster care, and (3) multi-national refugee parents and their infants. Each study employed highly innovative intervention approaches for engaging these populations while systematically documenting challenges, barriers, and solutions during implementation within randomized controlled or quasi-experimental implementation trials. Findings are particularly promising given the demand for expanding the reach of such interventions to families who face extreme access barriers.

Details

Abstract 1 Title: Optimizing infant social-emotional outcomes via virtual intervention targeting maternal depression and positive parent support: Mom and Baby Net randomized controlled trial

Introduction: Minoritized women in the U.S. experience postpartum depression at much higher rates than the general postpartum population, with substantial concomitant risks to infant social-emotional health and development. Maternal depression treatment is often siloed from nurturing parenting interventions that target infant social emotional health and development. These silos create a chasm in which mothers and their infants, who are least resourced and most in need of these interventions are least likely to access and engage in them. Within an NIH-funded comparative controlled trial, we examined effects of two virtual interventions, each of which integrated depression intervention into a parenting program focused on promoting infant development. In this presentation we will briefly describe the interventions, sample characteristics and study methodology. We will then report study outcomes and discuss engagement challenges, strategies for addressing them, and implications for future intervention research aimed at improving infant outcomes.

Method and Sample: 184 mothers with depression and their infants were randomized to one of two Internet interventions with remote coaching targeting depression and parenting. Mothers self-identified primarily as Black/African-American, were experiencing substantial socioeconomic stressors, and their infants were on average 6-months of age. The interventions included (1) the Mom and Baby Net program (MBN; a person-centered and cognitive behavioral approach focused on specific skills to improve mood and increase positive social-emotional support practices with their infants) and Depression and (2) the Developmental Awareness program (DDAS; a person-centered approach focused

on awareness of maternal depression and infant developmental milestones). Both interventions were identical regarding number of sessions, session length, and delivery mechanisms, including 24-7 Internet program access, requiring low literacy level, with immediate automated feedback, and between session coach facilitation.

Pre-post assessments included demographic interview, self- report measures of depression (Patient Health Questionnaire-9) and parenting knowledge (the Knowledge of Infant Social Emotional Development and Promotion), and direct observation of mother-infant behavior during semi-structured free-play (Landry Scales of Mother-Infant Interaction).

Results: Both groups showed significant pre-post reductions in maternal depression (F=6.80, p<.001). Mothers in the MBN group, compared to the DDAS group, showed significant increases in mother knowledge of infant social-emotional behavior and promotion (F=22.88 p<.001) and observed positive maternal behavior during interactions with their infants (F=17.40, p<.001). Mothers in the MBN group showed a trend toward significant pre-post decreases in negative behavior during interactions with their infants, whereas mothers in the DDAS group increased negative behavior over time (F=3.62, p<.059). Participants in both conditions reported high rates of satisfaction on a 5-point scale with 90% of mothers rating the program as “very acceptable” and 97% of mothers endorsing being “more or much more confident” in “my abilityto help my baby’s development”.

Discussion: Results were particularly encouraging with mothers in both groups demonstrating high levels of intervention engagement, program satisfaction, and significant reduction in depression symptoms. Moreover, the MBN intervention yielded strong effects on mother-infant interactive behavior. Program challenges, lessons learned, and implications for future research will be discussed.

Abstract 2 Title: A relationship-focused home visiting program for recently reunited birth parents in the child welfare system: Context, adversity, implementation, and satisfaction.

Introduction: Reunified birth parents are a stressed population with low incomes and high rates of substance use/recovery, mental illness, food/housing insecurity, as well as behavioral disorders for children. Prior studies have shown that Promoting First Relationships© (PFR), a brief 10-week home visiting program, to be effective in child welfare populations. For example, it has been shown to reduce entry into foster care, stabilize foster care placements, improve dyadic interaction and parents’ knowledge of infant/toddler social and emotional development, and improve child behavioral outcomes and stress physiology (e.g. improved cortisol and respiratory sinus arrhythmia). However, there are currently no published studies of the effects of PFR on reunified birth parents and their infants who are highly vulnerable because of the co-occurrence of serious risk factors and significant unmet service needs. Moreover, little is known about the context of home visiting with this unique population. Addressing this gap, we focus here on the implementation PFR in a randomized clinical trial (RCT) with a population of child-welfare involved birth families recently reunified after a foster care placement in Washington State.

Method and Sample: Our study enrolled 240 birth parent-child dyads and randomly assigned dyads to (1) Promoting First Relationships© (PFR) or (2) a resource-and-referral comparison group. Sixty percent of the sample N=144) were children under 3 years of age. The aim of PFR is to improve parent-child relationship quality, help caregivers better understand their children’s social and emotional needs, enhance parent-child dyadic interaction, and reduce reentry into the foster care system. PFR is a

strengths-based, video-feedback program that has met rigorous requirements to be included on several registries of evidence-based programs. Measures included demographic interview, the Childhood Trauma Questionnaire, Adverse Life Experiences, Difficult Life Circumstances, Infant and Toddler Social and Emotional Health.

Results: Seventy-four percent of the birth parents reported 4 or more Adverse Childhood Experiences (ACEs), compared to 12.5% in the general population (Centers for Disease Control, 2016); 72% of their children had already accumulated 4 or more ACEs at a young age. The average number of ACEs for parents in this study was 6.3, compared to the general population with an average ACE score of 1. At the time of reunification, 63% reported current housing insecurity, 86% received food assistance, 50% reported current issues with substances, and 40% reported their child had emotional or behavioral issues.

Discussion: Following presentation of the PRF home visiting program, as well as descriptive and qualitative results, we will focus our discussion on dyads with children under the age of 3 relative to: (1) adversities parents face, both historically (ACEs) and concurrently (daily life stressors, substance use and mental health challenges) and how these factors increase the risk of behavioral issues for their children; (2) Implementation challenges given the context of this population (intervention attrition, dosage, duration of service); and (3) parents' experiences with a brief, strengths-based, video-feedback home visiting program.

Abstract 3 Title: Implementing the SafeCare parenting model with children of migrants and refugees

Introduction: Promoting nurturing relationships through parenting programs is a key strategy for addressing children's exposure to adverse experiences. Parenting programs have been disseminated worldwide to promote social and emotional health. Fewer studies, however, have examined how parenting programs can be implemented with populations displaced by war or natural disasters, traumatic experiences that can make parenting more difficult, placing children at increased risk. In this implementation study, we adapted and implemented the SafeCare parenting model with Afghan, Burmese, Congolese mothers living in Clarkston GA, a refugee resettlement zone. A year-long adaptation process involving community members, implementers and model experts yielded an adapted curriculum. SafeCare was implemented using both community-based agencies, and independent community health workers. After briefly describing this adaptation process, we will present preliminary outcome data, and discuss challenges for each implementation type.

Method and Sample: Participants were 71 mothers with children ages 0-3 (24 Afghan, 26 Burmese, 21 Congolese). Each received the parent-child interaction module of SafeCare, and completed interviews pre-intervention, post-intervention and at three-month follow-up (n's to date = 71, 29, and 14;). Assessments included demographics, and standardized measures of positive parenting (Parenting Young Children's Scale), parenting stress (Parenting Stress Index), and child functioning (Deveraux Early Childhood Assessment). Participants were all female, 30.4 years old on average, and had an average of 3.0 children (range 1-9). Participants had lived in 2.5 different countries (range 1-5), had relocated 3.5 times, and had lived in the U.S. for an average of 5.0 years (range < 1 to 16).

Results: Of the 71 participants, 47 completed SafeCare, 22 are currently enrolled and 2 dropped out (96% completion rate). Satisfaction with the program was high with a mean of 4.4 on a 5-point scale. Skill acquisition as measured via behavioral observations by SafeCare providers was excellent; the

mean number of target skills demonstrated at baseline was 55.8% and rose to 96.7% by the end of the module (p <. 01). Mixed models showed that: self-reported parenting skills improved over time (p <. 01) from 4.16 to 5.11 on a 7-point scale (adjusted means). Parenting stress decreased from 79.7 to 69.0 (adjusted means), but did not reach statistical significance (p = .08). Parent reports of child attachment and child initiative both measured via the DECA showed improvement from Baseline (t-scores of 42.2 and 45.7, adjusted) to Follow up (t-scores of 49.3 and 52.7, adjusted), approaching statistical significance, p = .08 and .11.

Discussion: Results of this implementation are highly promising; and final data will be presented. Skill acquisition and satisfaction were high, and survey results are trending toward favorable program impacts. Implementation challenges included maintaining culturally and linguistically competent staff, competing demands for CBO implementation prompted by an influx of Afghan refugees, translation issues, and issues caused by COVID-19.

S.41 Digital Beginnings: Predictors and Outcomes of Media Use in Infancy

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Summary

Infants are born into a digital age. Studying the role of rapidly evolving media landscapes for infant development within family systems requires different perspectives and methods. This symposium unites scientists from 4 countries with distinct professional backgrounds and at different career stages. Taking a family perspective, talk 1 assesses parental mental health and family media use in daily diaries. The next talks focus on infant outcomes using experiments. Talk 2 examines media effects on infant sleep. Talk 3 tests features of design and content in word learning apps. Talk 4 shows that media use at age 2 longitudinally predicts preschool language development. Integrating our findings, the discussant will outline the interplay between infant and family characteristics, timing, content, and context in shaping short and long-term outcomes of media use. Our research contributes to creating digital environments that support infants in navigating the digital and analogue world.

Details

Abstract 1, Multilevel associations between parents' daily reports of burnout, parent-child interactions, and reasons for family media use: Parental burnout occurs in 8-10% of U.S. parents, which is higher than most countries, and has detrimental consequences for families (Roskam et al., 2021). Parents experience burnout when the demands of parenting exceed their resources and make them feel exhausted, overwhelmed, and emotionally distant from their children. Meanwhile, technology is the leading reason U.S. parents believe parenting is different today than 20 years ago (Pew Research Center, 2020), both creating parenting demands and providing parenting resources. Yet few studies examine parents' reasons for using media. This study examined parent-reported reasons for media use, parental burnout symptoms, and parent-child interactions using daily diary methodology. We hypothesized that parental burnout symptoms and negative parent-child interactions would be associated with more

regulatory media use (e.g., to calm themselves or their child), while positive parent-child interactions would be associated with using media together to relax.
A sample of 191 predominantly white (76%), college educated (88%), parents (90% mothers) of an infant between 11 and 23 months (M=17 months) reported daily parental burnout symptoms, media use, and parent-child interactions for 21 days. Media items captured the frequency of parents' media use to self-regulate (e.g., mentally "check out" or escape), regulate their children (e.g., calm a child), relax on their own, or relax with their children. A multilevel structural equation model controlled for the amount of time parents spent with their children that day.
Within-person effects showed that on days when parents felt more exhausted and overwhelmed in their parenting role (compared to their own average), they also reported more negative parent-child interactions (e.g., anger, difficulty managing kids) and more media use to self-regulate that same day. Parents' increased feelings of distance from their children was associated with finding their kids more difficult to manage, sharing less positive moments, and less media use to relax by themselves on the same day. Finding their children difficult to manage was the only significant within-person predictor of parents' media use to regulate their children's emotions (see Figure 1).
Between-person effects demonstrated that parents who reported feeling more overwhelmed on average (compared to other parents) also reported more negative parent-child interactions and more media use for all four reasons. Parents who reported using media more often to relax by themselves also reported feeling more angry with their kids than other parents, but also perceived them as less difficult and reported more positive moments together (see Figure 2).
Overall, these data show that day-to-day fluctuations in parental burnout and both positive and negative parent-child interactions predicted frequency of media use, but for different reasons. Further, how different parents reported using media varied across average burnout symptoms and perceived quality of interactions with their children. Notably, patterns differed for within- versus between-person effects, highlighting the importance of examining day-to-day fluctuations in burnout and media use. Ultimately, it will be important to develop tailored interventions that address daily parental needs to support healthy coping and children's socio-emotional development in the digital age.

Abstract 2, One episode late in the day keeps the good night away? An experimental study on pre-bedtime screen exposure and infant sleep: Sufficient and high-quality sleep is considered essential for infant development. Screen devices are suspected to interfere with infants' sleep patterns, in particular when used just before bedtime (Vijakkhana et al., 2015). Evidence supporting this notion, however, is mainly correlative and largely based on parental reports (e.g., Lund et al., 2021). In this preregistered study we experimentally investigated the influence of pre-bedtime screen exposure on objectively measured sleep behavior. We expected shorter sleep durations, lower sleep quality (i.e., higher sleep activity) and longer sleep onset latencies for infants watching age-adequate content on a tablet compared to infants looking at picture books before bedtime.
Infants aged 18 (n = 33) and 24 months (n = 27) were randomly assigned to a tablet or a picture book condition and their sleep-wake patterns were monitored using actigraphy for four consecutive nights. On the first night, baseline sleep was assessed and there was no media exposure for infants in either condition. On each of the next three evenings, caregivers either looked at Peppa Pig picture books or watched Peppa Pig episodes for 15 minutes with their infant, within an hour of bedtime. To control for potential artifacts in actigrams, caregivers completed a sleep diary. Actigraphy-derived sleep variables were averaged across the three intervention nights, standardized and computed to composite scores for sleep duration and sleep activity (cf. Staples et al., 2019). Sleep onset latency served as an independent indicator of sleep behavior.
During the baseline night, sleep behavior did not differ as a function of experimental condition within each age group. Applying a path-analytic framework, we predicted sleep scores from experimental

condition in each age group. Eighteen-month-old infants in the tablet condition had significantly lower sleep duration scores compared to infants in the picture book condition (b = -0.519, p = .005), after controlling for caregiver-reported habitual screen exposure. Experimental groups did not differ in their sleep activity (b = 0.01, p = .966) and sleep onset latency (b = -0.18, p = .583). In 24-month-olds, manipulation of pre-bedtime screen exposure had no effect on sleep scores (smallest p = .102).
To our knowledge, this is the first study assessing the causal role of pre-bedtime screen exposure on infant sleep behavior in an experimental design. In line with meta-analytically reported correlational findings (Janssen et al., 2020), our results suggest that 15 minutes of screen exposure within an hour of bedtime significantly reduces objectively measured sleep duration in 18-month-olds. However, this was not the case for 24-month-olds. To probe the robustness of the results, data collection is ongoing (preregistered sample size: n = 64 per age group). Moreover, it remains unclear to what extent screen-induced sleep disruptions impact infants' subsequent cognitive functioning. This is being addressed by measuring infants' immediate imitation and generalization performance, visual recognition memory, and divergent thinking the morning after the third intervention night (see Fig.1 for an overview on procedures). At ICIS, we will be able to discuss sleep's mediating role on the relationship between screen-exposure and daytime cognitive functioning based on the full sample.

Abstract 3, Exploring app features for supporting word learning by 2 year old children: Young children can learn language and literacy skills from touchscreen apps (Jing et al., 2023). However, children's touchscreen apps vary drastically in terms of design including sounds, animations and interactive elements on the screen that are not central to the learning material (Kolak et al., 2021). The aim of Study 1 was to explore the role of app design on 24–35-month-old children's ability to learn new words from an experimentally designed touchscreen app. Children were randomly assigned to either a simple app or a complex app condition, both apps were designed to teach children 3 novel words (gaz, zorch, sprock). In the simple app, there was a plain white background, no background music, only the target objects on the screen and a tapping action was required. In the complex app condition, there was background music, sounds when objects were touched, a colourful background, 5 images on the top of the screen that moved and made a sound when touched, and a dragging action was required. We hypothesized that children would perform better in the simple app condition compared to the complex app condition. 46 children took part in the study (Female = 25; M = 29.17 months, SD = 3.62 months; N = 33 simple app, N = 13 complex app). Word learning was assessed using a three-choice pointing task. Overall, children did not perform above chance in either condition (simple p = .621; complex p = .673) and there was no difference between the conditions (t(44) = -.613, p = .271 (1-tailed), d = -.201). Our experimental app, however, did not use a cognitively demanding task or provide specific feedback to support children's word learning. The aim of Study 2 was to tease apart the role of feedback and cognitively demanding tasks on 24–35-month-old children's ability to learn new words from an experimental touchscreen app with a simple design. The experimental app was designed to teach children six novel labels and word learning is tested by the app using a six-choice pointing task. Children were randomly assigned to one of three app conditions: 1) specific feedback (e.g., "Well done, you matched the shape") + cognitive problems (e.g., matching the object to a shape outline), 2) non-specific feedback (e.g., "Yay") + cognitive problems and 3) specific feedback + not cognitively demanding problems (e.g., popping bubbles). Data collection is ongoing and we aim to have 20 children in each condition. To date, 17 children have taken part (Female = 10; M = 29.35, SD = 3.37; specific feedback + cognitive problems N = 7, non-specific feedback + cognitive problems N = 7, specific feedback + not cognitively demanding problems N = 3). We hypothesise that children need both specific feedback and cognitive problems when using a touchscreen app to learn novel words. Ongoing work is also testing 3-year-old children in these studies. Taken together, these two studies will highlight the role of app design features for supporting children's word learning from touchscreen apps.

Abstract 4, Examining the longitudinal dynamics of language development, parental engagement, and child screen usage from age 2 to 5 years: The present longitudinal study investigated the intricate relationship between language development, parental engagement, and screen usage from age 2 to age 5 years (N=67). Vocabulary and grammar were assessed, at age 2 by the Swedish versions of MCDI and part of the Reynell Developmental Language Scales, and at age 5 by the Peabody picture vocabulary test and the grammatical index of the Clinical Evaluation of Language Fundamentals. Additionally, parental engagement was assessed, at age 2 through home recordings of child-directed parental talk using the automated Language ENvironment Analysis (specifically turn-taking), and at age 5 through the Parental Involvement in Developmental Advance, a subtest of the STIMQ2 survey. The Media Assessment Questionnaire-2 was utilized to evaluate the home media environment at both ages.
Correlation analysis unveiled a significant longitudinal association of both vocabulary and grammar between 2 and 5 years of age (p's <.05). Moreover, the child's screen usage at 2 years was correlated with screen usage at 5 years (p <.01) as well as negatively correlated with vocabulary at 2 years of age. Screen use at five years of age was negatively correlated with vocabulary and grammar at five. The proxy for parental engagement, parent-child turn-taking at 2 years, showed a correlation with parent-child educational activities at 5 years (p <.05).
To discern the predictive value of language, parental engagement, and screen usage, 2 linear regressions were conducted predicting grammar and vocabulary at five years of age, respectively. Each regression consisted of two steps, the first step contained the significant variables from age two (screen usage, parental engagement, vocabulary, and grammar), and the second step the variables from five years of age (screen usage, parental engagement, and vocabulary, if predicting grammar, or grammar, if predicting vocabulary). A significant regression was found for grammar ($F(7,33) = 5.7$, $p = <.001$) and the results indicated that early language development and parental engagement, alongside screen use at 2 years, were significant predictors, accounting for 45% of the variation in later grammar development. The variables at 5 years do not add to the model. A significant regression was also found for vocabulary ($F(7,33) = 4.1$, $p = .002$). Vocabulary was significantly predicted by the variables at 2 years (37%), while those at 5 years did not emerge as additional predictors.
In summary, the findings underscore the critical role of the child's early vocabulary and language development, coupled with early parental engagement and screen usage at 2 years, in shaping the development of vocabulary and grammar at age five. The child's development of language is complex and is affected by multifactorial variables, longitudinal as well as concurrent. This comprehensive model accounts for 37-45% of the observed variation in the child's vocabulary, and grammar ability, emphasizing the impact of early abilities, parental engagement, and the child's screen use from a longitudinal perspective.

S.42 Exploring infant's early social world and parent-infant interactions using neuroimaging and psychophysiological approaches.

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Details

Abstract 1,Title: Dorso-medial prefrontal cortex responses to social smiles predict sociability in infancy

The dorso-medial prefrontal cortex (dmPFC) plays a vital role in social cognition and behavior among humans. However, to date, little is known about what role the dmPFC plays in guiding overt social behavior during early development. The current longitudinal study examined the association between dmPFC responses and sociability in early development.

Based on prior work with adults, linking dmPFC to sociability (Powers et al., 2016) and with infants, linking dmPFC to sensitivity to social gaze (Grossmann, 2017), we hypothesized that dmPFC responses longitudinally predict sociability levels, with greater dmPFC responses to direct gaze-social smiles (friendly individuals) being positively predictive of heightened levels of sociability.

Brain responses were measured in response to social smiles (direct gaze smile minus averted gaze smile) and frowns (direct gaze frown minus averted gaze frown) using functional near-infrared spectroscopy (fNIRS) at 11 months (N= 76 typically developing infants; n= 38 female sex assigned at birth; Mage = 339.94 days, SE = 0.744). Individual differences in sociability were operationalized as behaviors indexing the seeking out of and taking pleasure in social interaction measured by using the Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006) at 18 months (Mage = 555.07 days, SE = 1.448).

Our longitudinal results show that greater engagement of the dmPFC when processing social smiles (ß = 0.237, t = 1.999, p = 0.050), but not frowns (ß = 0.031, t = 0.263, p = 0.793), at 11 months predict higher levels of sociability at 18 months. This demonstrates that early variability in dmPFC responses during positive social interactions are linked to later individual differences in overtly displayed social behavior.

The current findings further suggest that enhanced dmPFC engagement during social smiles is associated with higher levels of social motivation and reward, considering that higher levels of sociability at 18 months were characterized by greater seeking out of and taking pleasure in interactions with others. Future research should include direct measures of social motivation and reward to better understand the role of dmPFC in the development of sociability.

Abstract 2, Title: Neural and Behavioral Responses to Others' Struggles in 1-year-old Infants

Prosocial behavior, in the forms of both helping and expressions of empathy, emerges in the first few years of life (Vaish et al., 2009; Warneken & Tomasello, 2006). Individual differences in these early helping behaviors persist through childhood into adulthood, indicating that these early expressions of compassion truly represent the origins of human prosociality (Eisenberg et al., 1999; Roth-Hanania et al., 2011). In adults, two complementary brain networks support empathic and compassionate responding. One, sometimes called the mentalizing network, supports thinking about others' thoughts and emotions, while another, the pain network, is comprised of regions responsive to the sensory, motor, and affective significance of stimuli (Jacoby et al., 2016; Singer & Klimecki, 2014). Here we aim to test the role of these two brain networks in infants' early prosocial responses.

This study involves two phases. In the neuroimaging phase, 14- to 20-month-old infants wear a functional near-infrared spectroscopy (fNIRS) cap covering bilateral regions of frontopolar cortex, premotor cortex, temporal cortex and anterior parietal cortex, while watching two types of video stimuli. "Success" videos show an actor successfully performing an instrumental action (e.g. stacking blocks or drinking from a cup), while matched "struggle" videos show an actor either failing to perform the same actions or sustaining a minor injury (e.g. stubbing a toe or pinching a finger) in the process of executing them. The videos feature two different actors who each succeed or struggle an equal number

of times. Each participant sees up to 16 unique videos, presented in pseudorandom order and separated by interstimulus periods (slowly moving geometric shapes on a black background) that vary from 6 to 12 seconds in length.

In the behavioral phase, half of which occurs before the fNIRS phase and half after, an experimenter engages the participant in several different activities that provide the participant with a chance to help the experimenter. This includes picking up spilled blocks, opening a container so the experimenter can put blocks inside, pointing out a "lost" object that is clearly visible to the participant but not the experimenter, and handing back a dropped marker. In each case, we measure whether or not the participant helped, with or without prompting from the experimenter.

We have collected and analyzed data from 37 participants (target N = 45). Using an individual functional channel of interest approach to analyze the fNIRS data (Powell et al., 2018), we find higher activation to struggle than success videos in superior temporal cortex/temporoparietal junction (STS/TPJ) in both the right ($t(30) = 2.71$, $p = .011$) and left ($t(32) = 2.77$, $p = .009$) hemispheres. We did not observe significant differences in activation to the conditions in somatosensory and motor regions or medial prefrontal cortex in either hemisphere. Activation to the struggle condition in the right STS/TPJ is significantly correlated with composite helping scores in this preliminary sample ($r(29) = .38$, $p < .05$). These findings are consistent with the hypothesis that early helping behaviors are supported by infants' emerging understanding of others' goals and emotions.

Abstract 3, Title: Expanding the study of infants' neural responses to sociomoral scenarios: new ages and new paradigms

Behavioral research has shown that preverbal infants prefer prosocial to antisocial characters, suggesting that the ability to sociomorally evaluate others is early emerging (for review see Woo et al., 2022). However, some argue that infants' social preferences can be attributed to infants' responses to low-level perceptual cues in the scenes and do not reflect infants' true social understanding (e.g., Scarf et al, 2012). Neuroimaging is one way to address this alternative explanation through testing "neural signatures" associated with social versus attentional processing. Using electroencephalography (EEG), two studies have investigated neural mechanisms underlying infants' prosocial preferences in response to helping and hindering events in the "hill paradigm"(Gredeback et al, 2015; Tan & Hamlin, 2022). Their results showed different responses in social processing ERPs (P400/N290) but not in a general attentional ERP (Nc), suggesting that social processing is involved in infants' differentiation of sociomoral actors.

Although this past work is promising, open questions remain. First, infants' neural responses to sociomoral scenarios under 6 months are unexplored, leaving their developmental neural responses unclear. Further, previous studies focused on one scenario, the hill, so the observed neural activity patterns might not reflect responses to helpful/unhelpful individuals more broadly but may instead be specific to infants' processing of hill events. The proposed talk will report on two sets of studies investigating the development of infants' neural responses to pro/antisocial individuals across the first year of life and exploring the generality of previous findings.

Study 1 examined infants' neural responses to the hill paradigm in a pre-registered sample of 32 4-month-old infants (https://osf.io/q6mgy). This age range was chosen as infants as young as 3 months have been shown to prefer helpers in the hill paradigm (Hamlin et al., 2010), but 4 months is the earliest

age for EEG studies employing visual stimuli (Hadders-Algra, 2013). Data collection began in December 2022 and sufficient data should be obtained by July 2024 (current N= 29).

Study 2 is a conceptual replication of Tan and Hamlin (2022) using a distinct form of helping and hindering. Specifically, we examined 6- and 12-month-old infants' responses to the box paradigm (Hamlin & Wynn, 2011), in which a character attempts to open a box containing a toy but fails, then is alternatively helped or hindered in opening the box lid. While data collection for 12-month-olds is ongoing (current N=20), the ERP response of thirty-six 6-month-olds largely conceptually replicated Tan and Hamlin (2022), showing significantly greater amplitudes in the P400 component ($W(35) = 182$, $p = 0.0287$), as well as in the N290 component over the right hemisphere ($W(35) = 159$, $p = 0.0498$), to hinderers versus helpers, but no differences for the Nc component.

Overall, our current findings have provided evidence for the presence of social processes in infants' responses to pro/antisocial actors. Integrating these two studies will allow us to evaluate the degree to which prior neuroimaging results reflect neural responses to varied instances of helpful and unhelpful acts across development.

Abstract 4, Title: Neural and Caregiver Mechanisms Supporting Infants' Emotion-Perception Development within Real-world Social Interactions over the First Year of Life

Perceiving and understanding emotions is a cornerstone of successful human interaction. These critical emotion abilities develop over infancy (Leppanen & Nelson, 2006) and individual differences in early emotion perception predict later adaptive outcomes such as prosocial and empathic responding (Strand et al., 2016) and maladaptive socioemotional outcomes such as anxiety, depression and aggression (Trentacosta & Fine, 2010). Given the central importance of emotion development, critical open questions concern how emotion perception develops and what factors explain individual differences in this development. The proposed project tests the novel hypothesis that aspects of the caregiving environment—specifically caregivers' own emotionality—may shape how infants' brains develop and specialize to support their emerging emotion perception. We examine infants' and their mothers longitudinally when infants are 4- and 12-months-old. We use novel tasks to uniquely record infants' neural responses to real-world emotional signals (e.g., tone, facial expressions) that occur during live, naturalistic interactions with an experimenter and with their mother. We examine whether and how individual differences in mothers' natural variability in frequency and intensity of emotional expressions during infant-caregiver interactions relates to infants' neural responses to naturalistic emotional signals within social interactions.

We have collected data from 72 4-month-old infants, and have collected the 12-month follow-up from 48 of these infants (data collection for both timepoints is ongoing). Initial findings are starting to reveal infants' neural responses to their mothers' emotional signals that occur during live, naturalistic interactions. For example, infants' absolute alpha power (extracted from the infants' EEG recorded during the interaction) differed depending on the types of emotional signals their mother displayed (e.g., sad versus joy) at both 4-month and 12-month (see figure 1). Additional analyses (see table 1) of infants' resting state EEG at both 4- and 12-months also showed relations to mothers' self-reported emotionality (assessed via standard questionnaire). Most intriguingly, there is preliminary evidence that mothers' emotionality when infants' are 4-months-old longitudinally relates to infants' neural responses to their mothers' emotional displays within live, naturalistic interactions when infants are 12-months as indexed by infants' alpha ($N = 11$, $rs > 0.77$, $ps < 0.04$), suggesting that caregiver emotionality may help

shape infants' developing neural activity supporting emotion perception. Additional analyses will examine infants' more fine-grained event-related neural responses to individual maternal emotional events during the live interaction, and will examine findings with a larger sample (target N = 100).

In sum, results will offer novel insights into the developmental trajectory of infants' emotion-perception neural correlates by assessing infants' neural responses to emotional signals in ecological valid, live, interactive paradigms that closely match the natural social environment in which the infant encounters these signals, and can elucidate the critical contribution of caregiver emotionality to infants' emotion-perception development.

Abstract 5 – Title: **Early caregiving behavior, maternal touch and neural correlates of slow stroking touch stimulation in newborns: A MRI study -** ***Text:*** The co-construction of mother-infant interaction is crucial for infant's socio-emotional development (Montirosso and McGlone, 2020). A preferred channel during mother-infant early exchanges is tactile stimulation (e.g. affective touch) (Cascio et al, 2019). Affective touch has proven to be crucial for calming down the infant, for promoting sensations of pleasure and positive affect (Stack et al., 2010) and for reducing infant stress (Cascio et al., 2019) and discomfort (Maitre et al., 2017). Affective touch target c-tactile afferents: a group of fibres that constitute a subgroup of unmyelinated c-fibres that innervate hairy skin. These fibres react selectively to slow stroking stimulation of about 1-10 cm/s, the typical velocity of nurturing care (Croy et al., 2016) and are sensitive to temperature which resembles skin-to-skin contact (about 32°C) (Ackerley et al., 2014). In adults, affective touch involves activation of the somatosensory, the insular, and the cingulate cortices (Strauss et al., 2019). In infants it was observed that neural correlates of affective touch are the somatosensory and the insular cortices (Tuulari et al., 2019). We aimed to better examine the neural processing of affective touch in infants. First, we further investigated infant brain responses in two regions-of-interest (ROIs), the somatosensory and the insular cortices. Moreover, as in adults affective touch elicits responses across a wide range of brain region that may be crucial for development, we extended our investigation to the cingulate cortex. Finally, we also assessed the association between infant's brain responses in the abovementioned ROIs and maternal affective touch during mother-infant interaction.14 infants (8 female) were scanned while slept unsedated at 2.5 months. A block design fMRI experiment was performed with an affective touch stimulus administered by an experimenter with gentle brush strokes manually applied to infants' right tibia at a velocity of 5 cm/s. Before the scan, a 5-minutes mother-infant interaction was videotaped and affective touch were coded. For the ROI analysis insula, precentral and postcentral gyri were divided in 3 ROIs. The cingulate gyrus was divided in 4 ROIs. Standard GLM analysis was applied to fMRI data to compute the ROI. After adjusting for multiple testing, infants' brain responses were significantly > zero (one-sample t-test) in two region of the left cingulate cortex: the isthmus ($p < 0.000$) and the posterior cingulate ($p = 0.037$). Dfferences (two-sample t-tes) in left isthmus activation were found between males and females ($p = .024$). Pearson's correlations do not highlight a link between maternal affective touch and isthmus and posterior cingulate activation. A significant association emerged between maternal affective touch and left isthmus activation when controlling for gender ($p = .010$). Maternal affective touch associates with left isthmus activation in female ($p = .017$). Infants present a cerebral activation of the cingulate cortex consistent with neural processing of c-tactile activation in adults. Moreover, we confirmed previous results (Mariani Wigley et al., 2023) showing a sexual dimorphism in the neural processing of affective touch. Finally, we noticed some initial evidence supporting that the experience of maternal touch may play an important role in neural processing of touch.

Abstract 6 – Title: **Dynamics of mother-infant interaction in relation to interpersonal neural synchrony and attachment -** ***Text:*** From the moment of birth, infants actively engage in interactions, which allows

them to acquire social competence (Ilyka et al., 2021) and create social bonds with close others, such as their caregivers (Feldman, 2017). Starting at 3 months of age, dyadic interactions between infants and their caregivers are marked by reciprocal coordination between interactants (Beebe et al., 2010). The observable coordination is defined as the temporal alignment of behavioral and biological signals between interaction partners and is also known as interpersonal synchrony (Feldman, 2012). Importantly, during social interactions infants and caregivers do not remain in the same state throughout but shift between coordinated and miscoordinated states (Beebe & Lachmann, 2014). While coordinated interaction states might be marked by more predictable behaviors, fluctuation between states and miscoordinated states might be marked by uncertainty. Therefore, each interaction can be described by its amount of synchrony as well as its amount of uncertainty, also referred to as entropy (Seidenfeld, 1986). In recent years, interpersonal coordination on the behavioral level has been linked to interpersonal coordination on the neural level (Leong et al., 2017; Nguyen et al., 2020). Yet, we still know little about how these two levels are related to one another in early infancy and whether uncertainty in social interactions is related to interpersonal neural dynamics and predicts later attachment security. Consequently, the current study investigates the link between behavioral synchrony and entropy within nonverbal communication channels (touch, gaze and affect) and interpersonal neural synchrony (INS). Therefore, we simultaneously measured the neural activity of mothers and their 4- to 6-month-old infants (N = 61 dyads) using dual-functional near-infrared spectroscopy (dualfNIRS) during a naturalistic free-play. Additionally, we video-recorded the interaction for subsequent behavioral micro-coding of mutual gaze, positive affect and maternal touch. Longitudinally, we explored whether interpersonal synchrony on behavioral and neural level or entropy are predictive of future attachment. The Attachment Q-sort (AQS) was used to assess the attachment security at the infants' age of 12 months during a home-visit (N = 40). In contrast to previous empirical evidence, in our preliminary results neither the amount of behavioral synchrony nor entropy within nonverbal communication channels correlated significantly with INS. In the long term, interpersonal synchrony on the behavioral and neural levels did not correlate with attachment security, contradicting previous results. However, maternal touch- infant gaze entropy ($\beta = 0.208$, $p = 0.039$) and maternal touch- infant affect entropy ($\beta = 0.161$, $p = 0.018$) positively correlated with attachment security, highlighting the importance of variance in maternal touch during interactions with their infants for the establishment of secure attachment. Taken together, our results are in line with the optimum midrange model, stating that variability and fluctuation, to some extent, are desirable because they offer a scope of action for each interaction partner (Beebe and McCrorie, 2010). However, further studies using a holistic approach are needed to deepen our knowledge of interpersonal dynamics during early mother-infant interaction.

Abstract 7 – Title: **Associations between caregiver-infant vocal communicative display and infant autonomic profile leading up to and following 'deregulatory' events in day-long at-home recordings -** ***Text:*** Infants learn self-regulation by experiencing cycles of co-regulation with their caregiver; over time, infants internalise expectation of caregiver responses to deregulatory 'events' and through this learn to regulate their autonomic and behavioural response (Ham & Tronick, 2009a). From birth, infants express communicative displays automatically – directly as a function of physiological responses to their environment (Zeskind, 2013). Over time, infants develop the ability to use displays flexibly and intentionally (Matthews, 2020). Caregiver responsivity is crucial for this transition (Albert et al., 2018) but is sensitive to environmental stress: higher levels of household chaos relate to less responsive and more intrusive caregiving styles (Andeweg et al., 2020). Higher household chaos should associate with reduced caregiver responsivity to infant vocal displays of distress. Consequently, there would be a more flexible association between arousal and display. Sensitive maternal vocalisations would associate with slower/shallower routes into 'dysregulation' and infant recovery; inversely, insensitive vocalisations would associate with faster/steeper routes in and slower recovery. Day-long home recordings from typical

infants and mothers at 10 months; and high- vs low-chaos households of 12-month-old infants. N=110 datasets (N=32 general populations, N=78 high vs low chaos). Maternal vocalisations coded for affect/intensity (Smith et al., 2021), register (adult/infant-directed-speech), and type. Infant vocalisations coded for affect/intensity. We identified infant autonomic arousal events (5th percentile HRV) and gradient of arousal in the time window following (Wass et al., 2019). We used linear mixed effects models to identify which caregiver vocalisations associated with infant quieting. *Vocalisation type and autonomic arousal contingent on environment:* We subdivided vocalisations by vocal affect and arousal; and plotted two stacked bar charts for low-and high-chaos (Figure 2a). We calculated a 3-way ANOVA: percentage vocalisations ~ vocal affect bin x arousal bin x chaos. The 3-way interaction was not significant, but the 2-way interactions between chaos and arousal was significant F=3.07, p<.001: in the low chaos group there were more vocalisations overall at higher arousal. Separate 1-way ANOVAs: percentage vocalisations ~ arousal bin, were calculated for each vocal affect bin and chaos group (Fig. 2a). The low chaos group indicated significant relationship between negative affect and arousal F(4,134)=6.7, FDR-corrected p=.006: extreme negative affect was more likely at elevated arousal. This relationship was not present in the high chaos group (p=.62). *Caregiver vocalisation type and infant autonomic arousal:* We took two-minute windows before and after an arousal threshold crossing point, fitted a linear regression, and plotted the gradients against all caregiver vocalisations present (Fig. 2b&c). Exploratory analyses indicated a relationship between caregiver vocal intensity, register, and type, and the gradient into dysregulation – low- and medium-intensity, praise and infant action and maternal desires vocalisation associated with slower/shallower routes in. Conversely, adult-directed-speech and maternal desire vocalisations associated with infants not calming. Over time we predict patterns of caregiver responsivity associate with infants' vocal behaviour. This paves the way for language-based parenting interventions.

Abstract 8 – Title: **Heart rate modulation during early dyadic and triadic interactions** - ***Text:*** Early family interactions are strong predictors of children's emotional development (Cole et al., 2004; Favez et al., 2013; Lucarelli et al., 2017; Rattaz et al., 2023). Most studies on infants' physiological arousal regulation have been conducted in parent-infant dyads. Yet, child's social context is more complex and includes triadic interactions (Feldman & Masalha, 2010; McHale, 2007). This is the first study examining d how triadic vs dyadic interactions affect physiological arousal at a family level. Using the Lausanne Trilogue Play observational paradigm (Fivaz-Depeursinge & Corboz-Warnery, 1999) and simultaneously measuring the three partners' Heart Rate (HR), we investigated if the interactive context and position (i.e., active or passive), as well as the dyadic adjustment of the parental couple and the family alliance (FA) quality, modulate HR dynamics in a cohort of 4- month-old infants and their parents (N= 34 families). Results show that the child displays higher arousal activation (beats per minute, bpm) in the triadic exchange vs. the dyadic exchange (all *ps* < .01), probably due to a greater attentive effort. Conversely, both mothers and fathers reduce bpm during triadic interactions compared to dyadic interactions (all *ps* < .01), as if interacting with the adult partner's support reduces the physiological activation. During the interaction between parents, while their activation decreases, infants' HR further increases, maybe due to a lack of external regulation while a triadic attentive effort is still occurring (all *ps* < .01). Furthermore, parents' bpm decrease is also associated to dyadic adjustment dimensions of the couple (all *ps* < .05). Finally, the assessment of the FA quality pointed out that infant's HR is modulated by the family ability to organise their roles during the task (all *ps* < .01). Globally, parents' and infants' HR are regulated complementarily by the interactive context that is occurring, confirming its role in modulating the HR response. Thus, early triadic interactions can shape physiological arousal responses specifically and differently from dyadic ones.

S.43 Early development of the functional organization of the brain: Insights from diverse neuroimaging methods

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Summary

We propose a symposium where a series of papers will provide insights into the early development of the functional organization of the human brain using a newly available set of technologies. Paper 1 presents longitudinal studies using fNIRS to analyze developmental trajectories in patterns of functional connectivity within the default mode network (DMN) using fNIRS. In Paper 2, brain intrinsic timescales will be assessed with both fMRI and EEG to trace developmental trajectories and compare them with adults. Paper 3 presents data on the architecture of functional connectivity assessed with high-density EEG in a longitudinal sample from 6 to 36 months of age. Paper 4 presents data on the development of the DMN assessed with fMRI in prenatal, neonatal, and infancy stages of life. These papers represent a highly timely and innovative line of research that will advance the understanding of the development of the human brain.

Details

Abstract 1

Title**: Investigating functional connectivity development using fNIRS**

Presenter: Chiara Bulgarelli

Investigating functional connectivity development can offer valuable insights into the overall maturation of the infant brains, as FC is associated with myelination and synaptogenesis, fundamental processes for neurodevelopment (Dubois, 2015). While most of our knowledge on connectivity development comes from fMRI studies, this method has limitations with infants. Infants are scanned while asleep to limit motion artifacts' impact on data quality, limiting comparisons with data acquired from awake adult participants. Additionally, scanning participants outside conventional lab settings poses difficulties, limiting the generalisability of our findings. Functional near-infrared spectroscopy (fNIRS) is a promising alternative for studying neurodevelopment and to overcome these limitations (Gervain, 2023).

Over the past years, I have pioneered the use of fNIRS to delve into FC development. In this talk, I will present the first longitudinal study aimed to explore the developmental trajectory of connectivity between regions within the default mode network (DMN), a well-explored network in adults engaged during rest (Raichle, 2015). Connectivity within the DMN was assessed in 60 awake infants longitudinally between 11 and 36 months of age. Results showed that connectivity within the DMN increased during this period, peaking at 24 months (Bulgarelli, 2020).

As the DMN has been associated with abstract self-processing in adults (Davey. 2016), we next investigated whether this was a neural marker of emerging self-processing in infants. Some consider successful performance in a self-recognition task, occurring between 18 and 24 months of age, as an indicator of abstract self-processing (Rochat, 2003). However, others argue that passing this task merely demonstrates self-recognition (Mitchell, 1993). We found that infants who showed evidence of self-recognition had stronger DMN connectivity compared to infants who did not. This suggests that abstract self-processing may emerge as early as 18 months, and that the DMN may be neural marker of its development. Furthermore, our study provides additional evidence supporting the validity of self-

recognition as a tool for assessing abstract self-processing in infants (Bulgarelli, 2019).
In the last part of my talk, I will discuss my more recent work as part of the Brain Imaging for Global Health project (BRIGHT), an interdisciplinary and multisite study which investigates the effect of early adversity, such as undernutrition, typical of low-resource settings on brain development (Lloyd-Fox, 2023). For this purpose, fNIRS was successfully implemented in a poor-resourced setting in The Gambia, where field workers were trained for data collection and data quality assessment (Blasi, 2019). FC was acquired on 200 infants longitudinally at 5 time points between 5 and 24 months. We showed that frontal interhemispheric connectivity decreased with age, which is inconsistent with previous findings. Moreover, early growth only before the 5th months of life, and not after, positively impacted frontal interhemispheric connectivity, which in turn predicted preschoolers' performance at a cognitive flexibility task. These results hold paramount importance to guide timing of interventions, which benefit can be visible up to preschool age (Bulgarelli, under review).
All together these studies represent an innovative body of research that effectively used fNIRS to improve our knowledge on FC development, opening up future research avenues to leverage this tool to further understand neurodevelopment.

Abstract 2

Title: **Longitudinal development of intrinsic timescales in the infant brain: a multi-methods approach**
Presenter: Anna Truzzi

Adult humans and other mammals integrate information on different timescales. Different brain areas have different intrinsic timescales, with sensorimotor areas integrating information on short timescales and higher areas on longer ones (Ito et al., 2020). Our recent research in sleeping neonates found that intrinsic timescales already have a specific structure at birth, but different from adults (Truzzi & Cusack, 2023). Specifically, neonates showed longer overall timescales in all brain areas compared to adults. These results are consistent with findings showing that infants segment events on longer timescales compared to adults (Yates at al., 2022). These longer timescales could act as an inductive bias that favour learning of slower features in the environment. However, it remains unclear i) how the brain timescales develop throughout infancy, ii) how they relate to brain rhythms, and iii) whether longer timescales in neonates could have been caused by the sleeping state or by slower hemodynamic responses.
Here we investigate the development of intrinsic timescales by measuring their longitudinal development in awake infants at 6, 9, and 16 months using EEG during movie watching and comparing them to adults. We found that intrinsic timescales decreased with age (Fig.1). At six months, brain timescales in awake infants were still longer than adults. At 9 and 16 months the overall timescales were more similar to adults but the spatial pattern across electrodes still differed between infants and adults. In addition, we investigated the relation between the length of timescales and the brain rhythm properties in the alpha band. The alpha rhythm is the dominant oscillation in the brain and the most explored in developmental EEG studies and has been related to the integration of perceptual information (Freschl et al., 2022). With age the frequency of alpha peak increases, reducing the integration time-window, and alpha activity becomes more rhythmic and, therefore, self-predictable over time (Rico-Picó in prep). At 6 months, timescales negatively correlated across regions with the amplitude of the alpha burst, whereas the lag coherence in the alpha band was positively correlated to the intrinsic timescales at every age. By extending our earlier finding to EEG in awake infants, we have ruled out a hemodynamic or sleep-state explanation. Rather, the relation found between intrinsic timescales and alpha band features in the infant brain suggests that the origins of the early longer timescales lay in the brain rhythms.
Overall, we found that longer timescales lasted at least until 6 months of age, after which time point they began to shorten, allowing for faster-changing details to be encoded. This change of pace is likely related to myelination. Functionally, slower timescales in young infants could bring an advantage

because slower integration of incoming sensory information across longer timescales might help human infants to “take it slow”, focus on long-range temporal features. This could favour the development of more regularised, holistic representations supporting the learning of cognitive skills that rely on more abstract relations, not bound to fast-changing details.

Abstract 3

Title: **Early development of functional brain organization using high-density EEG**

Presenter: Josué Rico-Picó

An essential aspect of understanding how cognition is linked to the brain lies in examining how information processing is integrated across different brain regions. A fundamental approach to assess functional integration is modeling the interdependence of activity from various sources, known as functional connectivity. Existing evidence suggests that functional networks in the brain undergo significant reconfiguration during the first three years of life. Functional MRI (fMRI) studies have indicated a shift towards more segregated yet globally efficient networks. However, while fMRI provides high spatial resolution, it doesn't capture rapid changes in neural activity. Therefore, other neuroimaging techniques, such as EEG, can complement fMRI data. As of now, only a few cross-sectional studies have delved into electrophysiological network development, yielding mixed results.

The current paper aims to examine age-related changes in patterns of brain functional connectivity in a longitudinal sample of participants, followed through a series of four sessions from 6 to 36 months of age. We assessed network connectivity at baseline using high-density electroencephalographic (hd-EEG; 129 channels) registration and delineated network development with three different connectivity parameters in both binary and weighted networks across different frequencies of brain activity: alpha, theta, and beta bands. The strength of connectivity was computed using both imaginary coherence (Nolte et al., 2004) and phase lag indices (Stam et al., 2007) across any pair of channels with clean EEG signals. Subsequently, we explored developmental trajectories for various indices of functional network organization, including local and global connectivity strength, network efficiency, modularity of the network, participation coefficient of different nodes, and propensity toward a small-world network topology.

Weighted coherence-based connectivity networks exhibited the most significant and consistent changes. Connectivity networks demonstrated a consistent linear increase in strength, global and local efficiency across different frequency bands with age. Additionally, we observed a decrease in the participation coefficient, particularly pronounced at alpha and beta frequencies. Despite this, our findings revealed that the small-world topology and modularity of the networks were present from the first session (6 months of age). Furthermore, the number of modules and the small-world propensity of the networks remained stable across ages in different frequency bands. The topology of connections, as shown in Figure 2, reveals two clusters: occipital-parietal and frontal areas with strong local connections and weaker distal connectivity. Importantly, this topology remains relatively constant across age.

In summary, our results indicate a significant age-related increase in the brain's capacity to integrate information in different frequencies of electrophysiological activity. The clustering properties of the network also increased with age, regardless of the frequency band, while maintaining a small-world topology throughout the studied age range. The functional integration of information in the brain is crucial for cognitive development. Understanding the early development of this brain feature can provide valuable insights into overall brain maturation and may offer early markers for various neurodevelopmental risks.

Abstract 4

Title: **The functional phenotypical cornerstone of neurodevelopment**

Presenter: Pasquale Della Rossa

Functional neurodevelopment can be conceptualized as a time series transitioning from an embryonic system of prototypical functional configurations in the fetal layer to functional configurations in the

neonatal layer, which test essential intradomain and interdomain solutions in response to interoceptive and environmental stimuli, while functional segregation and integration occurs until a system of functional configurations reaches homeostasis. This functional system will in turn "express" into neurocognitive and neurobehavioral phenotypes in terms of intra-domain segregation/specialization, inter-domain integration/interplay and over-domain regulation/control (Della Rosa et al., 2021).
The cognitive essentiality hypothesis (Della Rosa et al., 2021; in prep.) posits that functional plasticity during neurodevelopment is aimed at establishing optimal system-level functional homeostatic configurations already at a fetal stage, between deep gray matter structures and with the cortical plate (Canini et al., 2020), to support functional dynamics between neonatal brain structures to shape a functional phenotypical cornerstone on which cognition and behavior pose foundations, later on in infancy and childhood.
The aim of the present study is to ground neurodevelopment in the binding between an individualized maternal frailty profile with fetal functional connectivity imprints in functional pathways across the neonatal brain to identify a neurocognitive-behavioral developmental offset time-continuum spanning from prenatal, neonatal to infancy stages of life.
50 mother-fetus-neonate-infant quadruplets were included in the present study. Mothers underwent the MaFra Inventory (Della Rosa et al., 2021) for assessing pregnancy risk factors. Fetuses and neonates underwent rsfMRI acquisitions on (8-12 mins) on a Philips Achieva 1.5T or 3T scanners. Infants underwent neurocognitive and neurobehavior evaluations in cognition, language, socio-emotional, and adaptive behavior domains with Bayley-III Scales at a single time-point between 6, 12, 18, 24 or 36 months. Fetal rsfMRI data was preprocessed with the RS-FetfMRI (Pecco et al., 2022) while a custom SPM12 pipeline was used for neonatal rs-fMRI data. Functional connectivity weights between pairs of 17 fetal and 49 neonatal brain regions (i.e. ROI-to-ROI) were computed with CONN toolbox for all fetus-neonate dyads. A neural network model (i.e. Many-to-Many LSTM) was trained and validated for prediction of cognitive, language, social-emotional, and adaptive behavior Bayley-III composite scores from i) pregnancy risk probability scores (i.e. maternal features); ii) fetal and iii) neonatal functional connectivity ROI-to-ROI weights (i.e. fetal and neonatal features).
The neural network performed with high prediction accuracy (RMSE = 0.175). Only 7 fetal and 25 neonatal ROI-to-ROI connections were deemed as important with the Mean of Absolute value of Errors (MAE) (i.e. the differences between the predicted values and the actual BSID-III score) falling below the 1st percentile.
The functional phenotypical cornerstone of neurodevelopment is shaped by prototypical functional configurations in the fetal layer, involving thalamus, caudate nucleus, hippocampus and amygdala, cortical plate and cerebellum, which lie a functional bridge with and between limbic (insular, cingulate, parahippocampal, temporopolar) and neocortical (occipital, temporal, frontal, parietal) regions in the neonatal layer. The fetal and neonatal layer skeletonize into a neurofunctional backbone with fossils traceable in cognition, language, socio-emotional, and adaptive behavior domains during infancy.

S.44 Investigating theta oscillations in infancy: How findings on language, cognitive and social processing can advance the field

Santiago Morales [1], **Tineke Snijders** [2], **Marlene Meyer** [3], **Alicja Brzozowska** [4], **Moritz Köster** [5]

[1] University of Southern California, [2] Tilburg University, [3] Radboud University Nijmegen, [4] University of Vienna, [5] University of Regensburg

Summary

Recent valuable findings of infant brain function across a variety of domains (e.g., language, cognitive and social development) are based on modulations in theta oscillations as measured by EEG. These effects have been observed both concurrently in contextual differences and longitudinally as predictive measures. However, given this breadth, the functional role(s) of infant theta oscillations remain an ongoing debate. The current symposium, combines interdisciplinary, cutting-edge research to stimulate discussions about the functional role of theta oscillations in early development. Across the four talks, the symposium examines the function of theta in language, social processing, attention, and learning. Speakers will focus on how their study contributes to a better understanding of the function of theta in infancy. Discussion will also focus on what is still lacking in our understanding of the neurocognitive mechanisms of theta effects and which future research is needed.

Details

Abstract 1 Title: The role of midline frontal theta oscillations in infant word learning from speech and song.

Theta oscillations in the brain are associated with memory formation as well as top-down control. In infants, the midline frontal theta response (3-6 Hz) has been linked to active learning (Begus & Bonawitz, 2020). In the current study, we investigated modulations in the midline frontal theta response in 10-month-old infants, while they were familiarized with words re-occurring either in the speech or the song modality. 40 infants participated in two experimental sessions (song and speech) while their EEG was recorded (Snijders et al., 2020). In the song session, infants listened to 20 songs of eight phrases. For each song there was a particular infrequent word that was repeated in each phrase. In the speech session, infants were familiarized with 20 words in a similar way, but now with the words occurring in spoken instead of sung phrases. For both the song and the speech session, after each familiarization phase there was a test phase with four spoken sentences, of which two contained the familiarized word and two a novel word. Theta power during the familiarization phase was calculated from 3-6 Hz using the fourier transform. Midline frontal theta over electrodes Fz, FC1, FCz, FC2, and Cz was compared for the first half versus the second half of each familiarization phase, for both song and speech modalities. Results showed an interaction between modality and familiarization half, with a significant decrease in midline frontal theta power in the song modality, and an increase in midline frontal theta power in the speech modality. A tentative interpretation of this interaction is that while songs are initially more engaging, they do not inspire an increased active word learning process in response to the repeated words, as speech does. At the conference, we will address this issue by additionally presenting results relating the midline frontal theta modulation to the ERP familiarity effect comparing the familiarized and novel words in the test phase. This will provide insight into how modulations in the midline frontal theta response relate to word learning in both speech and song.

Abstract 2 Title: What drives changes in frontal theta power in social processing?

Which brain mechanisms underlie early social processing in infants, such as their attention to others' infant-directed behaviors? Frontal theta oscillations are a promising neural candidate involved in how infants process and learn from infant-directed behaviors. Findings on neural processing of infant-directed speech provide evidence for an increase in infants' frontal theta power when listening to infant-directed speech compared to control conditions (Zhang et al., 2011). Across infancy, theta, in contrast to alpha networks, selectively gain connectivity strength for social stimuli (van der Velde et al., 2021). Moreover, frontal theta band modulations are associated with memory processes (Begus et al., 2015) and are

thought to reflect infants' learning of new information (Begus & Bonawitz, 2020). While this might suggest a particular role for theta band activity in social processing, others propose that theta power reflects more fundamental processing features such as processing prediction errors (Köster et al., 2021). What is the role of theta band activity in social processing and the link to more fundamental processing features such as information-theoretic surprise? Here we will present neurocognitive findings from an electroencephalography (EEG) study with 15-month-old infants using computational modelling to better understand the role frontal theta oscillations play in processing infant-directed actions. When parents show new actions to their infants, they tend to exaggerate in the way they move (van Schaik et al., 2020). Typically, making movements larger than usual is thought to draw attention in infant-directed actions. Recent findings suggest that parents might also exploit movement variability to highlight actions. In the current study, we manipulated whether an action was presented either with movements of normal, high or varied amplitude. To investigate how the different conditions affected infants' neural processing, we compared theta power (4-5Hz) in fronto-central channels between conditions. Theta power was significantly higher in the variable compared to the other conditions. These findings, however, raised the question, of what is so special about variability in movement amplitude. From an information-theoretic perspective, both the complexity and the surprise level are higher in the variable condition than in the other two conditions. To disentangle these two alternatives, we used a computational modelling approach in a post-hoc analysis to examine whether complexity or surprise were predictive of infants' frontal theta power (see Figure 1). Our results show that infants' frontal theta power was predicted by how surprising each movement was. Thus, surprise induced by variability in movements modulated infants' frontal theta oscillations. The temporary increase in theta power at surprising moments may lead to more robust encoding and memory formation. This is in line with the proposal that theta power reflects prediction errors, i.e. surprise of unexpected events in infants (Köster et al., 2021). Together, this offers insights into the brain mechanisms at play when infants process infant-directed behaviors. We will discuss how considering modulations in theta band activity in the light of fundamental information processing principles may be a fruitful avenue for future research to better understand (higher) social cognition.

Abstract 3 Title: Frontal theta modulation and neural entrainment to gaze-cued visual rhythms

Increases in frontal electroencephalography (EEG) theta power in infants while viewing novel non-social stimuli have been linked to enhanced learning, and research demonstrated that frontal theta power modulation in early infancy is a predictor of later cognitive abilities (Braithwaite et al., 2020). Yet, the mechanisms behind these effects are not very well understood. Rhythmic visual stimulation is a useful method to induce neuromodulating effects in infants, allowing to discern the functionality of different brain rhythms, including theta, in early human development. The goal of our study was to investigate the involvement of the theta rhythm in attention and learning in early infancy. We measured EEG while infants were viewing a nonsocial video for 2 minutes, and in a task involving gaze-cueing of visual rhythms presented at different frequencies (Figure 1). We intended to replicate prior results demonstrating an increase in frontal theta power over the course of the video viewing. Additionally, in the rhythmic visual stimulation paradigm, we hypothesized that infants would exhibit stronger neural entrainment to visual rhythms contingent with the gaze cue, especially if they were presented within the theta frequency band. Finally, we hypothesized that the degree of frontal theta modulation over the course of video viewing would be positively correlated with the strength of neural entrainment to gaze-contingent stimuli in the rhythmic visual entrainment task, corroborating theta's involvement in information encoding processes. We collected longitudinal EEG data from 6- and 12-month-olds (n = 140). In our preliminary analyses on data from a subgroup of 6-month-olds (N = 35 in the nonsocial video, N = 73 in the gaze-cue task) we were able to replicate the finding that frontal theta power increases over the course of video viewing (t(34) =

7.091, p < .001 for a one sample t-test testing correlation coefficients between segment number and average theta power per segment against the value of zero; group mean correlation coefficient M = 0.178, SD = 0.149). However, in a mixed effects analysis including Wald tests, we did not find evidence that neural entrainment was stronger for gaze-cued rhythms (W(1) = 0.91, p = 0.34), and no interaction between gaze direction and flicker frequency was observed (W(5) = 3.31, p = 0.71). We also did not observe a significant association between frontal theta modulation and neural entrainment to gaze-cued flicker (r(26) = 0.18, p = 0.38). The preliminary results need to be treated with caution, but they suggest that while the endogenous frontal theta rhythm seems to be involved in novel information encoding in 6-month-olds, socially-cued entrained neural rhythms corresponding to the theta band do not yet show functional differentiation at that age. The presentation will include updated and longitudinal analyses on data from 6- and 12-month-olds.

Abstract 4 Title: The theta-rhythms role in early brain development and learning

The ~3-6Hz theta rhythm has been assigned a crucial role in learning processes, from the first years of life to adulthood. In this talk I will briefly summarize the current state of knowledge and present our recent work on the theta rhythm in early brain development. Most critically, across several studies we found that the theta rhythm is present from the first years of life and involved in the processing of novel and unexpected information. This proposal is in further supported by two of our recent studies, in which we assessed the involvement of the theta rhythm in learning processes in infancy, childhood, and in adults. In a first study, we compared the representational similarity of object representations in 9-month-old infants and adults. While young infants processed category information slowly and much less reliably, at the theta rhythm, the same information was encoded fast and much more reliable in the adult brain, at the alpha rhythm. This suggests that the theta rhythm may be involved in the formation of semantic network, which then allow fast and efficient processing of visual information in the adult brain. In a second study we focused on how novel representations are built, by presenting several object stimuli repeatedly and some object stimuli only once, at 6 and 12 months, as well as 4 and 6 years of life. We applied oscillatory and connectivity analyses to characterize the formation of object processing over time and found that (i) theta oscillations increase over the first repetitions of a stimulus, but reduced thereafter, and (ii) connectivity was higher for unknown stimuli (only shown once), compared to already familiarized stimuli. This indicates that novel information is processes in more extended neural networks, to be integrated over time, when global activity becomes reduced. We will further present initial findings on theta-gamma coupling analyses in the infant brain, a mechanism associated with the formation of novel associative network in particular. We will discuss these findings in light of the idea that the theta rhythm is an ontogenetically preserved learning mechanism, allowing developing humans to integrate novel information into their developing (semantic) models of the world around them, starting in the infant years.

S.45 A deeper dive into the underlying mechanisms of infants' and toddlers' prosocial behaviour

Robert Hepach [1], **Annette Henderson** [2], **Milica Nikolic** [3], **Isabelle Périard** [4]

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Summary

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Details

Integrative Statement:

Other-oriented actions such as prosocial behaviour and cooperation have their psychological origins in the first two years of life but integrative accounts as to what motivates and shapes these behaviours remain scarce. Here, we bring together diverse research perspectives on the social environment that shapes infants' cooperation (Paper 1, Paper 2) and the causal mechanisms underlying helping behavior (Paper 3, Paper 4). Each paper addresses novel questions on (1) how parental values influence cooperative cognition in 10-month-olds (P1), (2) whether maternal mental state talk influences comforting, helping, and sharing at 15 months of age (P2), (3) how standardized assessments of motor and cognitive development in the first year of life predict helping at 16 months of age (P3), and (4) to what extent prosocial and social motivations underlie 14- and 24-month-olds' helping behavior (P4). The papers converge in their focus on the first two years of life, a period of development considered foundational for other-oriented actions while also being notoriously difficult to study. This is made possible by recruiting samples from four different countries, leveraging diverse study designs (longitudinal and experimental) and diverse methods including open-ended questionnaires on parental values (P1), standardized assessments of development (P3), eye tracking (P1 & P3), visual habituation (P1), pupillometry (P4), coding of mind-related talk by parents (P2), and capturing of emotions in children's vocalization and facial expressions (P2) as well as posture (P4). This symposium emphasizes the importance of considering how different levels of the infant's system converge to shape the foundations of prosociality.

Abstract 1, Title: "Why Should Children Help and Cooperate with Others?": Investigating Parents' Prosocial Values and Associations with Infants' Prosocial Development

Abstract 1, Text: "Children do learn what they live. Then they grow up to live what they've learned." Dorothy Nolte, Children Learn What They Live: Parenting to Inspire Values

The capacity to interpret and engage in a variety of prosocial behaviours begins to emerge during infancy. Evidence that infants engage in prosocial behaviour early in life raises important questions about the factors that support this development. While the extent to which infants are born with a "moral core" that supports prosocial behaviour remains a topic of much debate, it is clear that infants' experiences in their social world play a critical role in shaping prosocial tendencies. Building on prior work showing that parents' behaviour influences children's prosocial development, the present research examines another way in which parents may influence early prosocial development - through their prosocial values – and tests whether parents' prosocial values predict their infants' prosocial behaviour.

Using data from an ongoing longitudinal study, we will present findings from two open-ended questions designed to capture parents' prosocial values. Primary caregivers (N = 230) of a 9- to 10-month-old infant were asked why "children should help others?" and why "children should cooperate with others?" in the first phase of a longitudinal study on the development of prosocial behaviour throughout early

childhood. Parents' open-ended responses to each question were coded in two coding waves. First, we coded the extent to which parents' responses were self-oriented (e.g., "to get by"), other-oriented (e.g., "important for building friendships"), or neutral (e.g., "it's important"). Second, we coded the underlying competency the value reflects out of seven competency categories: Moral ("It's the right thing"); Conventional ("That's what we do"); Instrumental ("To get things done"); Developmental ("To learn how to work with others"); Survival ("That's how humans stay alive"); Prosocial ("To make other people feel good"); Other ("It's important").

Figure 1A shows that parents of 10-month-olds were more likely to provide self-oriented reasons for why they think that children should help and cooperate with others than they were neutral or other-oriented statements. Figure 1B shows that parents of 10-month-olds tended to report developmental and prosocial reasons for why children should help and work with others.

Analyses examining associations between parents' values and 10-month-olds' cooperative understanding (indexed via Henderson & Woodward's, 2011, Shared-Goals Visual Habituation Paradigm) revealed that parents who emphasised conventional competencies (i.e., "it's what we do") were more likely to have infants who identified the shared-goal structure underlying cooperative action ($N = 179$; $p = .011$). Parents who were more likely to emphasise the instrumental nature of why prosocial behaviours are important were less likely to identify the shared-goal nature of cooperative action ($N = 179$; $p = .049$). Further analyses will examine the stability of these associations across infancy and whether parents' values predict other forms of infants' prosocial behaviour.

These findings provide the first detailed information about parents' prosocial values when asked about why children should engage in two forms of prosocial behaviour and offer novel insights into how parents' values shape infants' prosocial development.

Abstract 2, Title: The role of parental mentalizing and infants' sense of self in infants' emerging prosocial behaviors

Abstract 2, Text: Infants start showing prosocial acts, such as helping adults by handing back the dropped objects, in their second year of life (Warneken & Tomasello, 2007). By 18 months of age, infants become increasingly helpful in a variety of situations (e.g., Svetlova, Nichols, & Brownell, 2010). These actions are considered foundations of human prosocial acts—behaviours benefiting others without providing an immediate payoff for the helper (Paulus, 2018). Accumulating evidence suggests that social interactions with parents contribute to individual differences in the timing and frequency of infants' prosocial behaviours (Dahl & Brownell; Warneken, 2016). However, the mechanisms through which parents influence their infants' prosocial behaviors remain unclear.

Theoretical accounts on the influence of parental factors on infants' prosociality propose that parents, through their practices, support the development of socio-cognitive skills and that this socio-cognitive development is crucial for infants' prosocial behaviors (Eisenberg & Valiente, 2002; Paulus, 2014). Parental mentalizing–treating their child as a mental agent–has been identified as an important factor for infants' emerging prosocial behaviors. Parental mentalizing is known to facilitate the development of socio-cognitive abilities in children (Hughes et al., 2014). In the first two years of an infant's life, self-awareness – a sense of self as a social object, is a socio-cognitive ability that undergoes important developments. Recent theoretical perspectives on the emerging sense of self in infancy suggest that affective experiences of being seen and recognized by others may be the crucial aspect of self-

awareness (Reddy, 2003) and that this experience may enable infants to differentiate between the self and the other and develop other-oriented concern (Kärtner et al., 2010), motivating the emergence of prosociality (Hepach et al., 2012; 2013).

In this talk, we will present findings from a longitudinal study involving 103 mother-infant dyads who visited the lab at 6 and 15 months. At 6 months, we measured maternal use of mind-related comments during free play with their infant. We coded both appropriate and non-attuned mind-related comments toward the infant (Meins & Fernyhough, 2015). At 6 and 15 months, we assessed infants' self-awareness through affective reactions to compliments (e.g., smiles, coy-smiles, vocalizations) (Colonnesi et al., 2013; Reddy et al., 2010) and mirror self-recognition (Amsterdam, 1972). At 15 months, we measured infants' helping, sharing and comforting in a series of tasks in which the child was prompted to (a) help the experimenter with an out-of-reach object (Warneken & Tomasello, 2007), (b) share toys with an experimenter (Brownell et al., 2013) and (c) comfort the experimenter who "hurt a knee" (Dunfield & Kuhlmeier, 2013). Data from both measurement waves have been collected and are currently being processed. We will present a mediation model examining whether more maternal appropriate mind-related comments are linked to infants' affective reactions, reflecting a developing sense of self. This, in turn, is expected to be associated with more frequent prosocial behaviors in infants. The findings of this study will shed light on early social experiences and socio-cognitive factors that may shape the emergence of infants' prosociality.

Abstract 3, Title: Infants' motor skills, cognitive functions and need understanding in the development of early helping behavior

Abstract 3, Text: Infants start to help early after their first birthday, for example by handing over an object that is out of reach to another person. Throughout their second year of life, infants reliably help another person in need. The past 15 years of research have shown that several developmental processes are involved in the development of this critical prosocial attainment. Yet, the early developmental trajectory of prosocial behavior, in particularly the critical determinants that precede the early ontogeny of helping behavior in the first year are not well understood.

Here, in a longitudinal study, we investigated critical developmental processes during the first year of life that may contribute to the ontogeny of helping behavior in the second year. Specifically, we assessed infants' gross and fine motor skills and cognitive development with the Bayley Scales of Infant Development at the age of 6 and 12 months and used maternal reporting through the Ages and Stages Questionnaire at 3, 6, 9 and 12 months. At 16 months, we assessed children's helping behavior in three instrumental out-of-reach tasks along with their motor abilities and social interaction skills. In addition, infants' prosocial understanding was assessed using an eye-tracking paradigm to test their understanding of others' needs. Using a within-subject design with 8 picture stories, we tested whether infants anticipate help towards a character that cannot reach a goal, by the means of infants' anticipatory gaze behavior towards a character in need versus a character not in need and looking time towards the expected outcome (character in need receives help) compared to the unexpected outcome (character that is not in need receives help).

First analyses, based on a sample size of N=70 indicated that children's motor development during the first year predict early helping behavior at 16 months (for global motor score across all 4 timepoints: $r(67) = .247$, $p < .05$), with the association primarily attributed to gross motor skills. Additionally, cognitive abilities assessed at 6 months demonstrated a positive association with helping behavior at 16

months : r(66) = .25, p < .05). Preliminary analyses of children's understanding of others' needs, as tested with the eye-tracking paradigm at 16 months did not reach statistical significance. The data of the anticipatory looking measure suggests a potential trend indicative of children's understanding of others' needs, with a higher percentage of anticipatory looking behavior on the character in need compared to the character not in need. There was no difference in looking times for expected versus unexpected outcomes. Further analyses are underway, and we will present our results with an anticipated final sample size of N = 75. In addition to examining associations with early motor skills, cognitive functions and understanding for others' needs, we will also present first analyses on early parental socialization styles and their relation to early helping behavior.

Our findings suggest that during the first year of life, motor and cognitive abilities are components of a developmental system contributing to the emergence of helping behavior early in the second year of life.

Abstract 4, Title: Prosocial and social motivations underlying young children's helping behaviour and social interactions

Abstract 4, Text: Children help others achieve their instrumental goals from an early age (Rheingold, 1982; Warneken & Tomasello, 2006). The extent to which this behaviour is driven by social motivation (to interact with others) or prosocial motivation (to see others helped) remains debated (Dahl & Brownell, 2019; Hepach, 2017). Here we conducted two studies with 10-, 14-, and 24-month-old children to better understand the mechanisms underlying helping behaviour in young children and how these may change across this crucial developmental phase in which helping first emerges (Paulus, 2014; Warneken & Tomasello, 2007).

In Study 1, we presented children (n = 118) with 3 different video scenarios. In the prosocial videos, a female adult was sorting or stacking objects while a second female adult was watching. The goal of the first adult was thwarted. After unsuccessfully reaching for an object that had fallen out of reach, the second adult picked up the object to complete the action. In the social interaction videos, both adults were engaged in the task, passing each object between themselves before the second adult stacked or sorted them. There was no interruption of the activity, and thus no help was needed. In the control videos, the first adult was engaged in the sorting or stacking activity without needing help or involving the second adult (who was not facing the scene). We found that children's changes in physiological arousal (pupil dilation) varied with the type of scenario they watched and with their age, $\chi2(2) = 8.70$, $p = .013$. Both 14- and 24-month-old children's pupil dilation increased in the prosocial condition, whereas in the social condition, such an increase was only observed at 24 months (see Fig. 2A).

In Study 2, we studied those 14- and 24-month-old children who also participated in Study 1 (n = 67). The order of the studies was counterbalanced. We measured children's positive emotions via changes in their postural elevation after they helped an adult, after they interacted with an adult (and no help was needed), and after watching an adult complete a task. The nature of the tasks mirrored those of Study 1. Children's changes in positive emotions varied as a function of both condition and age, $\chi2(2) = 6.81$, $p = .033$ (see Fig. 2B). At 14 months, children showed a greater increase in postural elevation after helping the adult than in the other two conditions. In contrast, no difference across conditions emerged at 24 months of age. Follow-up analyses on this latter finding using more conservative coding schemes to categorize helping behaviour revealed that differences in 24-month-old children's postural elevation were nuanced, $\chi2(1) = 11.54$, $p = .003$.

Together, these results suggest different developmental patterns for young children's motivation to help others compared to children's motivation to interact with others. We discuss these findings in light of current theories on the biological basis of altruism, social interactionism, and empathy.

S.46 Object Attention, Encoding and Word Learning: Developmental Changes and Possible Processes

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Summary

Learning what a word means requires attending to and encoding its referent, and this symposium provides insight into how object-attention processes develop in the service of word learning. Talk one shows that caregivers coordinate nonverbal sounds and speech with object prominence to support object attention and encoding in the first year. Talk two shows that by 12 months, simply labelling a prominent object facilitates identifying novel instances of the word's referent. Talk three presents a computational model that explains how words influence attention to potential referents, and why infants attend to novel objects when a novel word is heard. Talk four shows that the extent to which novel words lead to novel referent selection is influenced by temperament and context. These talks suggest specific mechanisms by which words impact object attention and encoding, and how different trajectories of lexical development unfold.

Details

Abstract 1, The role of synchrony in scaffolding infant attention to objects

Hearing words can boost infants' attention to and learning about objects, which in turn supports learning word-referent mappings. We sought to understand how these effects develop. One answer is suggested by laboratory studies showing that presenting words in synchrony with object motion 1) recruits attention 2) promotes encoding and categorising objects, and 3) eventually supports word-referent mapping (Gogate et al., 1998; Lany et al., 2022a, b). However, little is known about how caregivers use synchrony in unconstrained interactions with infants in the first several months of life, and whether and how it influences infants' attention to objects. Virtually no studies have considered this phenomenon in preterm and low-birth-weight infants, who are at risk for delays in attention and language development and show attenuated sensitivity to synchrony in a word-learning task (Gogate et al., 2014).

Thus, we tested how caregivers use synchrony when interacting with their 1-9-months-olds (ages corrected for prematurity). Low-risk infants (N=54) were born full term with no identified developmental risk factors. High-risk infants (N = 54) were primarily born preterm (between 28-37 weeks), and/or low birth weight (< 2000 grams), and all spent time in the NICU. We coded maternal bids for infant attention, including speech, nonverbal sounds (e.g., kissing, clapping), and sounds made by the toys (e.g., rattling,

squeaking), and whether the bid contained synchronous object motion. Finally, we coded whether infants attended (to either objects or mothers) or looked away.

Mothers of low- and high-risk infants did not differ in how many bids they produced, nor in the likelihood that their bids incorporated synchrony. Mothers were more likely to use synchrony in bids that contained nonverbal sounds, and in bids that combined speech and nonverbal sounds, compared to bids that contained only speech. Regardless of risk status, infants were more likely to attend to bids in which synchrony was present vs. absent. Infants were also more likely to attend to objects over their mothers when synchrony was present. However, high-risk infants were less likely to attend to bids of any kind, and more likely to look to their mothers than low-risk infants, especially at younger ages. Thus, even though high- and low-risk infants attended more to objects when synchrony was present than when it was absent, synchrony was not as likely to lead high-risk infants to attend to objects as it was for low-risk infants.

These results suggest that mothers successfully scaffolded young infants' attention to objects by using synchrony, especially between nonverbal sounds and objects. Furthermore, lower levels of attention to all maternal bids, and a higher tendency to attend to their mothers over objects, led high-risk infants to experience less sound-object synchrony. Thus, differences in high-risk infants' use of synchrony to learn words may arise from broad differences in the development of attention, rather than differences in caregiver use of synchrony, or in its' ability to recruit attention. Future research should determine how these effects cascade to affect encoding objects and learning mappings between words and objects.

Abstract 2, Labels facilitate infants' category matching

Recognising whether an object belongs to a given category based on perceptual similarities is essential for category learning. Several studies show that infants and toddlers benefit from labelling during object categorisation, helping them to recognise other novel members of the same category with ease (Fulkerson & Waxman, 2007; Waxman & Kosowski, 1990; Waxman & Markow, 1995). Labels are thought to facilitate detection of novel category members by guiding children's attention to the commonalities between exemplars (Althaus & Plunkett, 2015; Waxman & Markow, 1995) or by acting as a category placeholder. For example, while 2-year-old children will often fail to match a sample object with another member from the same familiar superordinate category (e.g., animal) in a behavioural Match-to-Sample task (Waxman & Kosowski, 1990), they succeed in identifying another category member when provided with a label. Though previous studies suggest labels support object categorisation, whether labels are *necessary* for infants to identify a novel category match is an open question. Most studies investigating infant object categorisation have relied on paradigms where infants are first individually exposed to several category exemplars, with or without a label, before testing if infants will look longer to an out-of-category object over a novel member of the familiar category. Here, we examined whether labels help 12-month-old infants to identify category matches and learn a category rule for basic-level categories using a novel, gaze-contingent eye-tracking adaptation of a Match-to-Sample paradigm. In a pilot study, we showed infants triads of objects from one of two unfamiliar real-life categories (birds and frogs): a sample and target object from the same category (e.g., two frogs) and a distractor (e.g., a bird). Infants first saw the target and distractor objects, one by one, before the sample was displayed. Fourteen infants were assigned to a labelling condition, where fixating the sample triggered a category label ("Look! A peko!") and 14 infants were assigned to an exclamation condition where they only heard exclamations ("Look! Wow!"). After fixating the sample object, we recorded whether infants looked at the target or distractor object during a test phase. Gazing at the target object triggered a match to

sample reward animation, reinforcing the category link. Analyses revealed that after hearing the audio stimulus, infants in the labelling condition (M = 63%, SD = 13%) directed their first fixations to the target object significantly more often than infants in the exclamation condition (M = 51%, SD = 13%; $t(26)$ = 2.487, p = .02, r^2 = .19). Infants who heard a category label (M = 76%, SD = 15%) also triggered the match to sample reward animations more often than infants who only heard exclamations (M = 54%, SD = 17%; $t(26)$ = 3.691, p = .001, r^2 = .34). These findings suggest that labelling plays an important role in infants' in-the-moment object category matching, supporting their recognition of another category member. We will also present findings from an on-going direct replication (N = 48, 24 infants per condition; based on *a priori* power analyses).

Abstract 3, To look or not to look: Insights and predictions from a process model of word-object interactions

The role of words in shaping infants' attention to objects has been a topic of extensive debate in the literature. Some research suggests that words serve as 'invitations to form categories' and help to support infants' abilities to group similar things together. Other research suggests that words 'overshadow' visual processing and reduce attention to objects. Bhat, Samuelson and Spencer (2023) recently examined how words direct attention to objects by generalizing a computational model of word learning to a set of studies by Mather and colleagues that directly pit measures of attention to objects in the context of words against a silent condition. The model—Word-Object Learning via Visual Exploration in Space (WOLVES, Bhat, Spencer & Samuelson, 2022)—instantiates processes of attention, memory, and word-referent association. It has captured data from 12 studies of infant and adult cross-situational word learning and provides the only developmental account of word learning in this task. The recent generalization extends the model to studies on infants' developing novelty preferences as a measure of visual processing. This talk will focus on model predictions about the influence of words on attention to objects.

In cross-situational word learning tasks infants are taught a set of novel word-object mappings via a series of trials that each present two objects and two words without cues to the individual mappings. At test, a single word is presented and the infants' preference to look at the object that most often occurred when that word was heard during training is measured as an indication of having mapped the word to the object. However, WOLVES shows infants' attention to the object at test is also influenced by the relative timing of word and object presentation (Figure 1, left) and predicts that infants will demonstrate better looking if the test procedure is modified to cue infant's attention to a central location before the word is presented (Figure 1, right). WOVLES also predicts that extending the amount of time allowed to explore the visual stimuli before a response is required can influence whether the model demonstrates a hypothesis testing or statistical accumulation strategy in CSWL.

In Mather et al.'s, (2011) studies, infants saw 30 trials that presented two objects; one of which repeated on every trial and one that was new on every trial. Nine- to 21-month-old infants were slower to develop a novelty preference when a word was also presented on every trial, compared to viewing the objects in silence. WOLVES suggests that the slower development of a novelty preference is due to growing associations between the word and the repeating object. Further, WOLVES predicts that presenting a new novel word on each trial will prevent the formation of these associations and thus not slow visual processing compared to a silent condition (Figure 2).

Together the model and simulations clarify how words influence attention to objects and sheds new light on these long-standing questions. Further, it highlights a role for computational models and rigorous theory in understanding infant behaviour in preferential looking tasks.

Abstract 4, How temperament and context-based novelty modulate children's referent selection and retention

Language acquisition researchers have come far in pinpointing the general cognitive processes by which children determine, and then learn, word meanings. By the end of the second year of life, children will typically map a novel label to a novel object, if all other potential referents are familiar. This referent selection behaviour is likely driven by a process-of-elimination approach, by which familiar competitors are rejected as potential referents before the novel target is selected (Halberda, 2006). Importantly, learning the novel label-object mappings, as measured via a subsequent retention test, is supported by heightened attention to the target object (Horst & Samuelson, 2008), raising the possibility that individual differences in children's attentional response to novelty could impact their word learning. In particular, temperamental shyness is characterised by an aversion to novel objects, settings, and people (Kagan, 1987); from this perspective, shy children may demonstrate differences in their attention to novel targets and subsequent retention of label-object mappings. To test this hypothesis, we conducted a series of studies in which two-year-old children saw an array of two familiar and one novel objects and were asked to select the referent of a novel label (e.g., "where's the cheem?"). In a face-to-face task administered by an experimenter, shyer children were less likely to select a novel object as the referent of a novel label. Furthermore, shyer children were subsequently less likely to retain the (few) label-object mappings that they had successfully formed via referent selection. To establish whether these results stemmed from shyness-related differences in attentional processing, we next ran an eye-tracking study using a screen-based adaptation of referent selection trials: Children were shown images of one novel and two familiar objects on a blank background, and heard one object labelled (novel targets were assigned novel pseudowords). Shyness was negatively related to target object looking during labelling, confirming the hypothesis that shyer children would show different attentional allocation to novel objects than less-shy children. These results held in a further study in which the label was spoken by an onscreen actor. Taken together, these studies demonstrate that shyer children's aversion to novelty results in a robust reduction in attention to the novel target during labelling. We then examined whether reducing the novelty of the task context allows shyer children to overcome their aversion to the novel objects and demonstrate successful referent selection and retention. A further face-to-face referent selection task was run, with the critical adaptation that the child's caregiver was trained to administer the task, thereby reducing context-based novelty. Results showed that the negative relation between shyness and referent selection was extinguished. Critically, shyer children subsequently outperformed less-shy children on retention. This finding suggests that reducing shyer children's context-based novelty aversion eased disruption of their attention to the target, allowing them to learn the label-object mappings. In conclusion, this work demonstrates the importance of acknowledging temperament-based individual differences when studying cognitive development, and highlights how intrinsic and extrinsic factors interact in shaping in-the-moment behaviour and longer-term developmental outcomes.

S.47 In the Driver's Seat of Development: Investigating Active Exploration and Subsequent Word Learning in Early Development

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Summary

Infants are curious and play an active role in structuring their own learning experiences, where such self-guided exploration is assumed to lead to greater engagement and better learning. Yet, little is known on how infants actually structure their own exploration and how that directly affects their word learning. This symposium presents four studies investigating this intricate relationship, showing that infants' attention allocation (1) during ambiguous naming events determined their object-label associations (2) possibly guided by the objects' visual dominance, (3) that they could retain object-label associations, both when presented in an active or passive way, emphasizing the resilience of infant learning, and (4) that a new validated measure of infant trait curiosity may explain some variance in this developmental trajectory of word learning. Together, these studies better our understanding of how infants' active role in their learning contributes to early language development.

Details

Abstract 1, Title: In-the-moment interest guides children's word learning in an ambiguous context

Over the first two years of life, children's vocabularies grow rapidly and by 30 months, children produce more than 400 words (Frank et al., 2017). This rapid growth is especially remarkable as the visual scenes that children encounter in their day-to-day lives are heavily cluttered (Clerkin et al., 2017). Thus, young children are constantly faced with referentially ambiguous word learning situations in which they have to map a word to one of many possible referents (Quine, 1960). Research suggests that the structure of the environment but also children's own biases and interests help mapping a word to an object in such contexts. One potential factor might be children's interest in objects in the world around them: Children learn and retain novel word-object associations when they are interested in the category the novel object belongs to (Ackermann et al., 2020, 2023). In the current study, we explore to what extent children's interest in a novel object can guide attention, and thereby disambiguate an ambiguous learning context to enable learning of novel word-object associations.
45 30- to 36-month-old children participated in an eye-tracking task that consisted of three different phases. In the first phase, children saw pictures of 16 familiar and four novel objects from four different semantic categories while their pupil dilation was measured as an index of their category arousal (familiar objects) and object arousal (novel objects). In a second phase, children were exposed to a referentially ambiguous word learning situation: They saw two novel objects from two different categories side-by-side and were exposed to only one novel label across ten naming events within this trial. Children's looking time to the different objects was measured to determine their relative interest in one object over the other. Both novel objects were equally likely to be the referent of the novel word, and any potential statistical, visual or pragmatic cues were avoided. In the subsequent word recognition phase, we used the intermodal preferential looking paradigm to test whether children had assigned the label to one of the two objects. We then analyzed to what extent referent assignment in the test phase was driven by category arousal, object arousal, or looking time to objects from different categories.
The results show that children's looking during the learning phase modulated their looking behavior at test: higher fixations to one object in the learning phase were positively related to higher target looking in the test phase, suggesting that children associated the label with the object that they looked more at during learning. Our findings shed new light on the question of how children resolve referential ambiguity: children's interest in the learning phase led children to disambiguate word-object

associations in an underspecified learning environment. This further shows that children structure their own learning environment: In the absence of other cues, children's word-object association was driven by their relative situational interest. Taken together, our results suggest that children take their interest into account when in-the-moment referent selection is not biased by external cues.

Abstract 2, Title: Testing real-world contingencies: How visual dominance may guide infants' exploration and subsequent word learning

Infants are prodigious language learners. By 6-9 months of age infants can recognize the names of at least a few common objects (Bergelson & Swingley, 2012, 2013). Nevertheless, there is no clear consensus on how infants learn to link object names to seen things. When an infant hears an object's name, many objects could be in view, making it difficult to determine which object goes with the spoken name. Studies that have recorded infants' first-person perspectives from cameras placed on babies' heads demonstrate that infants hold objects close to their faces, making held objects appear larger in view (i.e., "visually dominant"; Yoshida & Smith, 2008; Smith & Pereira, 2011). Successful object name learning in such studies is correlated with named objects being visually dominant (Yu & Smith, 2012; Pereira et al., 2014). Thus, visual dominance has been hypothesized to direct infants' gaze toward the visually larger object and away from visually smaller objects, helping infants to associate heard names with the dominant referent object; however, this hypothesis has not been experimentally tested.
We designed an experiment to test this hypothesis by manipulating the visual size of objects on a screen. Thirty-six infants (17 females; M age=12.9 months, SD=4.10) participated. Infants sat on their parent's lap in front of a screen while an eye tracker recorded their looking location and duration. Infants viewed up to 160 trials that presented one large "target" object and two "distractor" objects that were seven times smaller (Figure 1A-B). Participants were randomly assigned to either hear the name for the target object presented on each trial (Naming condition) or hear non-naming speech (No-Naming control condition), to examine how visual dominance affects object-label mapping (Figure 1B,D). If visual dominance is a primary factor influencing infant looking, we expect significantly greater looking to the target compared to the distractors across both conditions. On average, infants looked at only two of the three objects presented per trial (M=1.9 objects, SD=0.38), typically the target and only one of the distractors ("D1"; "D2" refers to the less-looked-at distractor; see Figure 2). Within-subjects t-tests revealed that infants looked equally to the target and D1, and least to D2, ps<0.001). Thus, despite the target being seven times larger, looking time did not differ for the target and D1, suggesting that visually dominant objects might not draw infants' attention as much as previously thought. Nevertheless, visual dominance likely played some role in looking behavior, since the target was one of the two objects most looked at per trial. Future analyses will examine how looking behavior may have changed across trials, as well as how visual dominance relates to word learning.
To further examine the role of visual dominance, we are running a second experiment in which objects are equally sized (Figure 1C; see Figure 2 for preliminary data from five infants). If visual dominance does not play a role in guiding infant looking, we should obtain similar results in the dominant and equal-size experiments.

Abstract 3, Title: Does curiosity enhance word learning in infants? Preliminary results from a Registered Report

The cognitive mechanisms and benefits of active learning in early child development are poorly understood. The current study investigates 20-23-month-old infants' curiosity-driven information selection in a novel word learning task, designed to identify the hypothesized advantage for active

learning over passive learning. We used gaze-contingent eye tracking to enable infants to exert choice over which of the four objects presented on a screen are labeled at a certain point in time. As we were interested in whether the freedom to select information benefits word learning, we contrasted this active learning (Curiosity) condition with two passive learning control conditions. In one control condition (Random control), which is akin to traditional ways of presenting information in word learning studies, objects were labeled in a random order. In the other control condition (Yoked control), infants experienced a sequence of labeling events that was actively generated by another infant in the curiosity condition. Infants' learning of word-object associations was compared across active and passive learning conditions.

We expected to observe advantages for curiosity-driven learning on subsequent label recognition such that infants in the Curiosity condition would show better retention of novel object labels than infants in the Random and Yoked control conditions. Such a result would have provided evidence that self-motivated information selection and the freedom to choose what to learn about are important aspects of infants' learning in the real world, optimizing their learning by reducing referential uncertainty, and thus providing support for the learning progress theory of curiosity.

We tested 57 20-23-month-olds in three between-subject conditions. Following the learning phase, which differed on whether infants could trigger the objects to learn a label or were presented with those passively, infants were tested on their label recognition. We computed the baseline-corrected proportion of cumulative looking time to the target object at test. The one-way ANOVA between Curiosity, Yoked, and Random conditions revealed no significant effect of condition; $F(2, 54) = 0.62$, $p = .544$, $BF01 = 4.57$. Label retention was above chance in all three conditions ($ps > .05$).

The results therefore indicate no significant differences due to the learning condition, contrary to the hypothesis that active information selection would lead to greater retention. Instead, infants across all conditions learned up to four novel object-label associations, emphasizing the resilience of infant learning mechanisms. These results are preliminary as testing is ongoing (per the IPA Stage 1 Registered Report in Developmental Science) and expected to be completed in January 2024: with an application of the Bayesian sequential testing principles, up to 75 infants will be tested in total for three between-subject conditions or until the Bayes Factor is conclusive with BF above 10 in support of either the null or the alternative hypothesis. Regardless of the final result, this study advances our understanding of early word learning, and of the effects of active learning in infants.

Abstract 4, Title: The Infant and Toddler Curiosity Questionnaire: A validated caregiver-report measure of curiosity in children from 5 to 24 months

Humans are curious. Especially children are known for their drive to explore and learn new things which is crucial for developing in and navigating through our complex world. Naturally, some children may be more curious than others, leading to differences in how they structure their own learning experiences, subsequently impacting on their developmental trajectories. However, there is a crucial gap in the research field for a reliable measure of such differences early in development. Across four studies, we present the development and assessment of the Infant and Toddler Curiosity Questionnaire (ITCQ), the first caregiver report measure to fill this gap. Items cover observable exploration behaviors in 5- to 24-month-olds to capture general tendencies of their desire to actively explore their immediate surroundings (e.g., "When my child encounters an object, they typically seem interested in its properties (e.g., how it feels, tastes or sounds like, etc.)") and are evaluated on a 7-point Likert-scale with an option of 'not applicable (NA)' for behaviors the child has not yet or not recently displayed. Exploratory factor analyses and structural equation modelling on a sample of N = 370 UK caregivers (children's age range: 4.50-24.44 months, M = 13.52, SD = 5.22, 50.81% female; 97% monolingual English; 82% of primary

caregivers indicated to have achieved a degree in higher education) led to the final selection of 23 items and provided evidence that the scale is unidimensional enough to allow for an overall curiosity score, whereas three emergent sub-factors of exploration types (sensory, investigative, and social exploration) showed acceptable internal consistency for explaining additional variance in the data. Furthermore, the scale had good test-retest reliability after 7 to 14 days (N = 67; ICC(A,1) = .82, p < .001) and significantly correlated with the child's temperament (N = 75; positively with surgency (r = .39, p < .001) and effortful control (r = .25, p < .05), negatively with negative affect (r = -.27, p < .05)) offering evidence of its validity as a trait measure. Additionally, we found that differences in exploration tendencies captured by the three sub-factors at 11 months longitudinally predicted productive but not comprehensive vocabulary at 24 months (N = 28). Together, these results strongly support the scale's reliability and validity, showcasing the ITCQ as a powerful tool for developmental research.

S.48 Mechanisms Underlying the Effects of Prenatal Risk on Infant Physiological, Social-Emotional, and Sleep Outcomes

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Summary

This symposium brings together an international group of scholars from the US, India, and the Netherlands and includes 3 papers, each of which employ multi-method, observational longitudinal designs in racially/ethnically diverse samples. Paper 1 demonstrated that prenatal maternal emotion dysregulation had a significant indirect effects on infant baseline RSA and toddler dysregulation via parenting stress. Paper 2 demonstrated a direct association of prenatal neighborhood risk on infant socioemotional outcomes and an indirect association on maternal insensitivity via infant temperamental reactivity among dyads in which the mother had elevated depressive symptoms. Finally, paper 3 demonstrated a significant multichain indirect effect of prenatal risk, including socioeconomic risk, stressful life events, and neighborhood violence on infant sleep problems via perinatal emotional distress and maternal sensitivity.

Details

Abstract 1

Title: Testing a Developmental Cascade Model from Prenatal Maternal to Toddler Dysregulation through Parenting Stress and Infant Autonomic Reactivity

Early behavioral dysregulation is associated with the development of psychopathology (e.g., Cole et al., 2008), though our understanding of the prenatal developmental origins of psychopathology risk are limited (Doyle & Cicchetti, 2018). Prenatal maternal emotion dysregulation may contribute to widespread and cumulative effects on parents and infants. First, prenatal maternal emotion dysregulation may shape the early postnatal environment through parenting stress, with studies linking prenatal internalizing symptoms to postpartum parenting stress (e.g., Huizink et al., 2017). Secondly,

prenatal maternal emotion dysregulation may impact biological systems underlying regulation in infants (e.g., Ostlund et al., 2019). The current project tested a developmental cascade model by examining indirect pathways from prenatal maternal emotion dysregulation to 18-month toddler behavioral dysregulation via domains of parenting stress and infant autonomic physiology during a parent-child interaction.

Data were collected from a subset of 227 parent-child dyads from a longitudinal study from pregnancy to 36-months postpartum. White, non-Hispanic individuals represented just over half (56%) of the sample; 24% were Hispanic. The median household income was $50,000-79,000. Female infants made up over half of the sample (52%). During the third trimester, mothers completed the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). At 7-months, mothers self-reported their parenting stress levels using a questionnaire modified from the Parenting Stress Index (NICHD, 2005; Anhalt et al., 2007). The competency and attachment subscales were used. Respiratory Sinus Arrhythmia (RSA), a measure of autonomic physiology, was collected while parent-child dyads completed the still-face paradigm (Tronick et al., 1978) during a laboratory visit at 7-months. RSA reactivity was modeled as a growth model with an intercept set at baseline, and slope to represent overall linear change in RSA across episodes. At 18-months postpartum, mothers completed the Infant and Toddler Socioemotional Assessment (ITSEA; Carter et al., 2003).

A structural equation model fit the data well, and standardized estimates can be found in Figure 1. Of note, parenting stress around competency was positively associated with baseline RSA (i.e., intercept), such that higher stress about parental competency was associated with lower baseline RSA (B=0.29, p=.01). Higher levels of stress about the quality of the parent-child relationship were associated with less reductions in RSA (i.e., slope) (B=0.34, p<.01). Additionally, higher levels of parenting stress around competency (B=0.38, p=.02) and lower levels of baseline RSA (B=-0.33, p=.03) were associated with higher levels of toddler dysregulation at 18-months. The indirect path via competency stress was significant from maternal emotion dysregulation to baseline RSA (B=0.10, p=.03), and from maternal emotion dysregulation to 18-month toddler dysregulation (B=0.13, p=.03).

Findings support a developmental cascade model from prenatal maternal emotion regulation to 18-month toddler dysregulation. The association between prenatal maternal emotion regulation and parenting stress around competency may have important implications for the development of biobehavioral domains of children's regulation and dysregulation and provide an avenue for early intervention. The present study contributes to our understanding of prenatal developmental origins of psychopathology risk, and mechanisms underlying intergenerational associations of dysregulation from parents to children across the perinatal period.

Abstract 2

Title: Prenatal neighborhood risk and infant social-emotional outcomes

Accumulating evidence demonstrates the importance of the prenatal environment for infant health and developmental outcomes. Yet most work in this area has focused on maternal risk factors such as substance use or mental illness, rather than community level risk factors such as indicators of neighborhood context. Furthermore, prior work focused on community level risk factors for child outcomes have either have predominantly focused on birth outcomes, such as low birthweight, or on developmental outcomes among older children. The current study examined the impact of the prenatal

neighborhood context on infant social-emotional outcomes and parenting behavior at 12 months postpartum.

295 mothers and their infants participated in this longitudinal study. Mothers were 18 to 44 years of age and were racially and ethnically diverse (40% Hispanic; 42% White, 19% Black, 7% biracial/multiracial, 32% other races). 60% of mothers had less than or equal to a high school degree, 65% were unemployed, and all received public assistance programming (cash assistance, food stamps, or WIC). 53% of infants were female.

At a prenatal research assessment mothers reported on their experiences of depressive symptoms and reported on indicators of family socioeconomic status that were used to generate a socioeconomic risk composite. Home addresses were geocoded to determine census block and a prenatal neighborhood risk index was generated for each address. At 12 months postpartum, mothers and their infants participated in a free play task to assess parenting sensitivity and a frustration task to assess infant negative temperamental reactivity. Mothers also reported on their infant's social-emotional competence, problem solving abilities, and behavior problems.

Results demonstrated that prenatal neighborhood risk was negatively associated with mother reported infant social-emotional competence ($r = -.14$, $p = .033$) and problem solving ($r = -.15$, $p = .022$) and positively associated with observer ratings of infant temperamental reactivity ($r = .14$, $p = .042$) at 12 months. These results were consistent when controlling for family socioeconomic risk, maternal depressive symptoms, and child race. However, maternal depressive symptoms moderated the impact of neighborhood risk on infant temperamental reactivity ($B = .14$, $p = .047$) such that neighborhood risk was positively associated with temperamental reactivity only among families with high maternal depressive symptoms ($B = .29$, $p = .005$).

Prenatal neighborhood risk was not associated with maternal sensitivity, either independently or in conjunction with maternal depressive symptoms. In contrast, infant temperamental reactivity was negatively associated with sensitivity ($r = -.17$, $p = .012$), and tests of moderated mediation demonstrated that there was a significant indirect effect of neighborhood risk on maternal sensitivity through infant temperament reactivity but only among families with high maternal depressive symptoms (95% CI = -.0136, -.0001).

Abstract 3

Title: Pathways from Prenatal Risk to Infant Sleep: The Role of Maternal Emotional Risk and Sensitive Behavior

Previous research has established that difficulties in sleep regulation and consolidation during the early years of life can adversely affect various key domains of child development including socio-emotional, cognitive, health, and brain development (El-Sheikh & Sadeh, 2015). There are various parental and environmental factors that put some children at heightened risk of experiencing sleep dysregulation. Prior research has shown that socioeconomic risk factors, stressful life events, and neighborhood violence during the prenatal period undermine sleep regulation and consolidation among infants (El-Sheikh et al., 2013; Scaramella et al., 2008; Ward et al., 2023). However, the mechanisms that explain these associations remain unclear. Thus, we examined maternal emotional distress and maternal

sensitivity as the intermediary factors that explain the relationship between prenatal risk factors (i.e., socioeconomic risk, stressful life events, neighborhood violence) and infant sleep problems.

The sample included 299 mothers (57.3% White, 30.6% Black, and 7.8% Hispanic) and their infants (50.5% female). A latent factor of prenatal risk was constructed using three indicators: socioeconomic risk, stressful life events, and neighborhood violence. Perinatal emotional risk was constructed as a latent factor based on mothers' self-reported depressive symptoms (CES-D; Radloff, 1977) (prenatal and 2 months postpartum), prenatal trait anxiety, state anxiety at 2 months (Spielberger, Gorsuch, & Luschene, 1970), prenatal difficulties in emotion regulation (Gratz & Roemer, 2004), and prenatal neuroticism and agreeableness (NEO-FFI; McCrae & Costa, 2004). Maternal sensitivity during distress was assessed using observer ratings at 2 months during the Still-Face re-engagement episode. Infant sleep problems were assessed using the Brief Infant Sleep Questionnaire (BISQ; Sadeh, 2004) at 6 months.

The hypothesized model was tested with structural equation modeling using Mplus (Figure 1). The model fit the data well; RMSEA= .07, 95% CI [.06, .09], SRMR = .06, and CFI = .92. Regarding the covariates, infant sleep risk at 2 months was significantly associated with sleep risk at 6 months (β = .40, p = .00). Consistent with our hypotheses, higher prenatal risk was positively associated with maternal emotional risk (β = .59, p = .00) and higher emotional risk was negatively associated with maternal sensitivity (β = -.20, p = .03). Further, there was a negative association between maternal sensitivity and infant sleep problems (β = -.16, p = .02). Turning to the indirect effects, the indirect pathway from prenatal risk to sleep problems at 6 months was also significant via emotional risk and maternal sensitivity (β = .02, B = .02, SE = .01, 95% CI [.001, .064]).

In sum, results support the view that prenatal risk factors put infants at higher risk of sleep problems by elevating maternal emotional distress, which in turn contributes to lower maternal sensitivity. Lower maternal sensitivity likely undermines infants' ability to self-settle to sleep both initially and upon night wakings. The findings underscore the importance of providing mental health services and interventions to promote sensitive parenting to foster positive child outcomes.

S.49: Beyond the lab: Examining linguistic input across cultures and contexts

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Details

Abstract 1, Title: Caregiver and child language during shared picture book reading

While reading to children is positively associated with language outcomes, the causal pathways are less well understood. Hypotheses for the pathways fall into two non-mutually exclusive categories: the caregiver-child conversation, and the vocabulary and sentence structures, contained in the text of the book. Both these hypotheses point to the differences between the language produced during shared book reading and the language produced in other contexts. To evaluate these hypotheses and to

understand what book reading might uniquely provide, we need to better understand the language produced during shared book reading and how it varies across families and books.

Method: Participants & Materials: We built a corpus of caregiver-toddler (12 dyads; 24-36 moa, 7 female, 5 male) shared book reading interactions recorded in homes. The corpus contained 60 sessions of reading unfamiliar books (~10 hours; 4 provided unique titles) and 99 sessions of familiar books (~8 hours; 88 family-owned unique titles). Books varied across many dimensions including length and syntactic complexity. Analysis: Child and parent speech was transcribed and annotated for whether the speech was book text read aloud or conversation. Speech type differences were analyzed by book familiarity (novel, familiar) and characteristics (text length, syntactic complexity). The language input generated during reading sessions was compared with other sources of child-directed speech for age-matched children to understand similarities and differences across child-directed speech contexts.

Results: The familiar books were shorter in length (in words) than the novel books, consequently novel books elicited longer reading sessions than familiar books (~9 vs. ~6 minutes). Caregivers overwhelmingly read the text of novel books (98% of text read out loud). However, for the familiar books, particularly those with more text, caregivers summarized or skipped text more frequently (~70% of text read aloud).
Books varied in the profiles of language they generated, and differed from other conversational contexts. Short and simple books promoted more conversational turns and familiar books promoted more conversation turns then new books (See Figure1 & Table1), but interestingly, fewer turns than non-book reading contexts. Beyond turn taking, relative to other conversational contexts, book reading generated overall more words, more lexically diverse talk, and longer utterances, but these tendencies depended on characteristics of the book being read. Longer and more syntactically complex books showed greater differences from non-book contexts, driven largely by greater proportions of book text read aloud in those episodes. Specific patterns observed for different book types will be discussed.

Conclusion: The language produced during picture book reading varied by book (novel vs. familiar; short vs. long, syntactically simple vs. complex). Additionally, books varied from other contexts of child-directed speech along different dimensions. These results provide important facts about the types of language generated during book reading, and have practical implications for studies that aim to compare different contexts of child-directed speech, as well as for intervention studies that use picture books. The pathway to the positive language development outcomes from shared book reading may be a varied range of diverse experiences rather than one specific type of language input.

Abstract 2, Title: Novel noun learning during naturalistic picture book reading in 14-, 18-, and 22-month-olds

While infants can learn words from daily life before age one and get much better at understanding familiar words after the first birthday (Bergelson, 2020), lab studies that teach novel words often find fairly limited learning and retention, even in toddlers (Vlach & Sandhofer, 2012). Moreover, current word learning accounts generally do not systematically quantify how much or what kind of exposure to new words and referents children need to add words to their lexicons, or the role of age (and its concomitant cognitive and linguistic advances) in this process. Tackling this, we used a picture-book training protocol to span the space between learning new words from naturalistic and temporally-extended exposure vs. brief and controlled new word exposure. We quantified how caregivers read a

simple book with 3 new words to 14-, 18-, and 22-month-olds, and whether differences in caregiver reading were linked to differences in children's novel word production.
Over two weeks, caregiver-child dyads read a short book containing the novel words "shang," "blick," and "dax" 2x/day, and audiotaped the reading sessions. We found that although instructions were consistent, caregivers' reading did differ by age in two ways. First, while caregivers typically spent ~2 minutes/session reading the short 100-word book, reading time did increase significantly across age groups (M14=1.2 (SD=.16)min., M18=1.8(SD=.71)min., M22=2.5(SD=.81)min.;Pearson's R=.59, p<.05). Second, caregivers of older children provided significantly more extra-textual extensions by e.g. prompting children to count the target objects or asking questions about their properties; (M14=0(SD=0), M18=1.5(SD=1.8), M22=5(SD=1.9), Pearson's R=.70, p<.05; Figure 1). This provides initial evidence that parents titrate new word exposure by child age, even in this simplistic book-mediated setting where they needn't.
Younger infants (who had expectedly smaller productive vocabularies) rarely produced the new words. In contrast, all 22-month-olds said a target word and, by the final session, 60% of the 22-month-olds produced target words prior to their caregiver reading the words aloud. This provides some evidence that at least for 22-month-olds, roughly an hour of exposure to 3 new words spread over 2 weeks is sufficient to bring a word into the productive lexicon.

Finally, we tested whether these findings were linked: did reading differences connect to production differences? We found they did: a greater number of caregivers' extra-textual extensions predicted a higher probability of the child saying a target word based on a mixed effects logistic regression model (β= 0.68, $p < .05$; Figure 2). Not only are older infants cognitively and linguistically more equipped to learn novel words but their language environment provides enriched experience of the new words; these are likely symbiotic processes. Ongoing eye-tracking data collection will augment the book-reading data to more fully reveal how age may influence the earliest stages of word learning, and how this links with naturalistic exposure to words and referents.

Abstract 3, Title: How do speech and gestures support language development in storybook reading?

A wealth of studies reports positive correlations between shared book reading and a range of language development measures. There is robust evidence to suggest that extra-textual talk generated during shared book reading contains a higher level of structurally rich linguistic construction than child-directed speech generated in other everyday contexts such as mealtime, dressing, and toy play (Hoff-Ginsberg, 1991; Cameron-Faulkner et al, 2003). However, it is unclear how young children process the diverse linguistic input provided during shared book reading in real time and how additional extralinguistic input, such as gestures, works together with linguistic input in this learning process.
We conducted a dual head-mounted eye tracking study to investigate how toddlers learn the correct word-object mappings by attending to the right object at the moment of parent naming in shared book reading. Specifically, we investigate (1) linguistic constructions in object naming utterances generated by parents when narrating picture books; (2) whether gestures from both parent and child influence the linguistic constructions of parent speech and (3) the roles speech and gestures play in directing the child's attention to the named referent.

Method: We collected 45 book reading sessions from 16 parent-child dyads (M = 19.03 m.o., range:18~24.4 m.o.).

Results: (1) Parent naming utterances contain a mixture of simple and complex grammatical construction types. Parents produced significantly more subject-predicate constructions (67%) than simple fragments (22.4%) and complex grammatical constructions (10.6%, $F(2,132)= 265.02$, $p<.001$). This finding is in line with earlier work showing that books with little to no text allow parents to freely create stories using more canonical 'who did what to whom' constructions (Noble et al., 2018). (2) We grouped parent naming utterances based on whether they are paired with a parent gesture, a child gesture, or no gesture. We found no group difference in terms of the relevant frequency of each grammatical construction categories ($F(6, 236) = .37$, ns), indicating that children are constantly exposed to a mixture of simple and complex utterances regardless of gesture use. (3) When gestures are provided during naming, they successfully drive the child's attention to the named referent. Children are more likely to look at the named referent when the naming events are paired with a child gesture or a parent gesture. Gestures lead to increased target look for all types of naming utterances, but it took children longer to find the target as the complexity of utterances increases (Figure2).
Our findings suggest that shared book reading provides toddlers with a linguistically diverse language training ground. This diversity is likely to be advantageous as it provides children with more opportunities to gradually build the multi-layer structure of language. Gestures provide learners an easier pathway to associate the word with its referent in the world and this associated visual referent is likely to facilitate language comprehension in real time. This work provides insights into how parents and toddlers coordinate diverse information sources in real time to facilitate language learning from book reading.

Abstract 4, Title: Relating properties of parents' speech to the infant's referential world

In parent-infant interactions, parents produce both clear and hard-to-understand pronunciations, and refer to both present and absent objects. Considered separately, these two aspects of the language-learning environment would seem to pose a major challenge for early word learning. In this study, however, building on work by Beech & Swingley (2023), we consider parents' speech and the referential world simultaneously to ask whether clearer parental pronunciations tend to coincide with moments where the word's referent is present in the infant's field of view. Alignment of phonetic clarity and referential transparency would suggest that while many instances of words are hard for infants to learn from (being both phonetically reduced and referentially opaque), other instances provide especially clear opportunities for word learning.
We analyzed video recordings from 30 North American mothers speaking to their infant in the home (collected monthly from 6 to 17 months; Bergelson, 2017), focusing on discourse-first mentions (n=2077) of seven frequent concrete nouns ("ball", "book", "car", "dog", "kitty", "milk","water"). Trained coders annotated each instance for referent presence using infant first-person video data, and measured the word's duration. Additionally, we recruited 48 native English speakers to listen to each word in isolation and rate its clarity (scale from 1-5). Listeners' judgments were z-scored, and averaged to obtain a phonetic clarity rating for each word.
Using mixed-effects logistic regression, we found that referent presence was significantly predicted by duration of the spoken word ($\beta=0.25$, $p<0.001$; Figure1). Slower, more careful pronunciations tended to coincide with moments when the word's referent was visible to the infant. This effect was in the same direction but not statistically significant using the words' rated clarity ($\beta=0.04$, $p>0.05$). Listeners' clarity judgments may have been affected by the recording quality of the audio file in addition to the clarity of the speech itself. We are gathering recording quality assessments to better account for this possibility. Including infant age in the model revealed a significant main effect of age on referent presence ($\beta=0.03$, $p=0.037$). Thus, older infants were more likely to hear references to co-present objects (Figure 2), which

could reflect parents' changing perspective on their infant as a communicative partner.
We also investigated whether the phonetic clarity of parents' pronunciations varied based on the child's knowledge of the word, using monthly MB-CDI (parental vocabulary report) data for children in the corpus (phonetic_clarity ~ produced_yet + (1|word) + (1|family), restricted to 12+ months). This analysis revealed a marginally significant relationship between phonetic clarity and whether the child was reported to say the word (β=0.10, p=0.073), with known words corresponding to greater phonetic clarity.
Infants experience language in complex contexts. We find that while parents' pronunciations vary in their duration and clarity, these properties are aligned with other aspects of the language-learning environment, including the referential transparency of the visual world and the child's skill as a communicative partner. In this way, patterns within parental language input may guide infants into language understanding.

Abstract 5 Title: **Infant directed communication in Tanna, Vanuatu and Vancouver, Canada**

Infant-directed speech (IDS) has been shown to play a key role in language development. Previous research, however, has also shown significant variability in the amount, kind and from whom infants are hearing directed speech. For example, recent research has found very little IDS (Cristia, 2023; Cristia et al., 2023) in non-Western, small-scale societies — including children growing up in small-scale societies on Tanna, Vanuatu — which is surprising given that IDS is widely assumed as a common feature of human caregiving in well-studied urbanized populations. Here we propose that IDS is only one of a suite of important caregiving behaviors that are produced during interactions with infants. Other non-verbal infant directed behaviors (IDB) may be just as important in supporting early social and cognitive development (Kosie and Lew-Williams, 2023). We examined 97 semi-structured video observations of caregivers and their 20-month-old children (55 girls) in rural Tanna, Vanuatu and urban Vancouver, Canada. We identified and compared the proportion of time caregivers spent engaging in IDS and IDB during these interactions, both within and between societies. IDS was defined as any vocalization produced by the caregiver during the caregiver-infant interactions. IDB was defined as any non-verbal interactive behavior produced by the caregiver during the caregiver-infant interactions. Preliminary results indicate variability between societies in how much IDS and IDB infants are exposed to in the first year and a half of life. We proposed a model for language learning that reconceptualizes communication with infants as a diverse set of caregiving behaviors, of which speech is just one aspect, and which is more inclusive of non-western and less well-studied societies. In a broader scope, this study aims to take a step toward a more generalized understanding of language development in children that recognizes different developmental pathways within multi-cultural communities, and which can improve policy making for such populations.

Abstract 6 Title: Defining linguistic input: Illustrating variation through Tsimane children linguistic experiences

Existing studies on early child language input have used varied methods to measure and estimate input quantity. This diversity has also been reflected when defining "what counts as input" for child language acquisition (Scaff et al., 2023). The definition of "input" can range from counting exclusively clear child-directed speech from adults (Gilkerson et al., 2017) to including distant, overlapping, and overheard speech (Casillas et al., 2020). This diversity poses difficulties in understanding the true extent of children's linguistic exposure. This investigation explores how different definitions of linguistic input influence quantities and sources of verbal input among Tsimane'. The Tsimane' are a subsistence

population of the Bolivian Amazon, previously described as receiving little amounts of child-directed speech (Cristia et al., 2019). By proposing two contrasting scenarios — a restrictive and a permissive definition of input — we aim to characterize the possible range of variation as a function of input definition among Tsimane' children. The restrictive scenario includes only vocalizations that are near, non-overlapping, and speech in quality (thus excluding crying and laughing for example). In contrast, the permissive scenario includes near and distant, overlapping and non-overlapping vocalizations, and non-speech sounds. We manually transcribed one minute of each recorded hour using naturalistic recordings from 24 participants (ages 6 to 68 months, median age 32 months, 33% females). On average we transcribed 13 minutes/child (ranging from 4-16 minutes). We categorized each vocalization by broad speaker and addressee types, distinguishing between the "key child" (the one wearing the recording device), the main female voice (MFV), other adults, and other children. Other speaker types, included only in the permissive definition, involve vocalizations that could not be easily attributed: two or more people were speaking simultaneously and speech sounded distant.
The findings reveal substantial disparities in estimated input quantities between the restrictive and permissive definitions. Under the restrictive definition, Tsimane' children are exposed to around 4.21 minutes/hour of total verbal input and approximately 43 seconds/hour of child-directed (CD) verbal input. The permissive definition estimates total input at 16.87 minutes/hour, and 10.6 minutes/hour of CD input, showcasing the substantial impact of differing definitions on input quantity. Regarding the input sources, our results show more similar patterns across restrictive and permissive definitions. The most common sources of CD verbal input are other children, followed by the main female voice (MFV), and then other adults in both definitions. The contribution of MFV is twice that of other adults in both scenarios. However, distant speech significantly alters input composition in the permissive definition. These nuanced insights into the quantity and sources of linguistic input among Tsimane' children emphasize the complexity of understanding language acquisition. The study underscores the necessity for sophisticated methodologies and ethnographic work to contextualize findings and paving the way for a comprehensive understanding of early language development across cultural settings.

Abstract 7 Title: Universals and cultural specifics of infant directed singing

Infants are drawn to the acoustic features of infant directed singing (Trainer et al., 1997; Nakata & Trehub, 2011). They show a strong preference for infant directed singing over adult directed singing and there are several theories regarding the potential function of this behavior modification of adults in the presence of infants. Some have suggested that infant directed singing serves a similar communicative and pedagogical function to infant directed speech. It draws infants' attention, communicates emotional warmth, and serves to establish mutual joyful moments between the dyad, whereas adult directed singing likely serves other functions such as social learning of cultural routines and norms. Only a handful of studies have examined the acoustic properties of infant directed singing in less well studied societies (Hilton et al., 2022). This is problematic as it results in a narrow perspective regarding the form and function of this seemingly universal behavior. In this study, our goal was to examine and describe the acoustic properties of infant directed singing produced by mothers and fathers in a cross-cultural dataset consisting of two urban societies (Vancouver, Canada and Atlanta, USA) and two rural subsistence societies in the south pacific (Tanna, Vanuatu and Yasawa, Fiji). As part of a larger study, we video recorded caregivers with their infants during a semi-structured 10-minute observation. Our participants were 57 mothers and 17 fathers in four societies – Atlanta, Vancouver, Fiji and Tanna. From these observations, we watched each video and extracted any moments of singing directed toward the infant.

To examine the acoustic properties of the speech directed toward the infant, we examined female and male caregivers separately. We examined the mean pitch, range, and pitch variability of speech produced by both mothers and fathers toward their infants in a semi-structured observation. We did not compare it to adult directed speech. Interestingly, we see a similar mean pitch, pitch range and variability in all samples, yet there were interesting differences in both our between and within culture comparisons. We discuss the cross-cultural variability in light of existing data on IDS and ADS from each society (Broesch & Bryant, 2014; 2018; McClay et al., 2021).

S.50 Fundamental Mismatches Between Controlled Experiments and Lived Reality in Understanding Infant Development

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Summary

Rich characterizations of infants' everyday experiences often reveal notable differences from experimenters' assumptions about the context of development and learning. The talks in this symposium highlight discrepancies between infants' real, everyday input and experimentally-derived assumptions—across domains that include caregivers' response to infants' distress, the everyday emotional facial expressions that infants encounter, the role of context in shaping multidimensional caregiver-infant communication, and cultural variation in infants' motor experience—and links these naturally-occurring features of infants' everyday lives to real-time behavior and/or development. Overall, our symposium showcases the value of comprehensive descriptions of infants' real-world input, across modalities and cultures, and highlights implications for ecologically-informed research and interventions.

Details

Abstract 1: Everyday behavioral mechanisms of infant regulation: caregiver proximity and latency, but not affective quality, predict cry duration in ecologically valid interactions

Caregiver responses to infant distress are theorized to form the foundation for social-emotional development. However, there is limited data on parents' responses to infant distress in everyday settings. This is critical as gold-standard assessments of caregiver responses to infant distress likely restrict variability and timing of behaviors important for regulating distress, including caregiver proximity, vocalizations, and affect. In the current paper, we 1) descriptively characterize caregiver responses to infant distress in real-world everyday settings and 2) examine the behavioral mechanisms that predict real-time infant regulation in these interactions.

N=87 families with infants aged 1-10 months shared 24-72 hours of LENA audio recordings collected over a week. N=38 24-h recordings, each from a distinct infant (Mean age= 4.52mo, SD= 2.33 mo), were semi-randomly selected for annotation. Research assistants coded all instances of infant fussing and crying, with instances occurring within five minutes of one another grouped into a single distress episode. A second team of coders annotated various audible dimensions of caregivers' response to each episode of distress, including the latency of first response, the affective quality of caregiver's response,

caregiver proximity (using audible cues such as footsteps, volume changes and rustling clothes suggesting holding), and caregivers' sensitivity to distress for each episode.

Infants had mean 12.3 (range 1-26) episodes of distress in 24h, ranging from 5 seconds-123 minutes in duration (Median=3.69min, SD=10.22min). Latencies for the caregiver's first response to distress varied widely, ranging from 0 seconds to 18.38 minutes, with 50% being 13.2 seconds or longer. Latencies to fuss-only episodes ("fusses") were shorter (Median= 8.3sec, SD= 65.2sec) than latencies to episodes that included crying ("cries"; Median= 19.2sec, SD= 110.0sec; Wilcoxon p <.005), suggesting that faster responses may prevent escalation of fusses into cries; alternatively, parents may prioritize responding to fusses. Caregivers were proximal to infants for 78.6% of cries.

Multilevel models indicated that for individual episodes of distress, caregiver sensitivity predicted shorter infant distress (p<.005). Sensitivity to individual episodes was significantly associated with a faster latency to respond, caregiver proximity, and affective quality during the episode (all p<.005). However, only latency to respond (p<.005) and caregiver proximity (p<.005) - but not affective quality (p>.05) - predicted infant distress duration. We interpret this to suggest that shorter latencies to respond and physical proximity are the behavioral mechanisms that mediate the effects of caregiver sensitivity on real-time infant regulation in everyday settings.

Overall, our results highlight that everyday caregiver responses to infant distress are meaningfully distinct from those observed in structured interactions. Where proximity is fixed in gold-standard interactions, caregiver proximity is variable at home as caregivers move freely to attend to everyday needs. Relatedly, latencies to respond to infant cues at home are much longer than those commonly observed in face-to-face interactions (e.g. VanEgeren et al, 2001). Critically, ecologically valid variation in these two key behaviors serves to regulate infant distress in everyday settings, with implications for theories of socioemotional development.

Abstract 2: All is not as it seems: Using naturalistic data to test classic theories of emotion

Learning about emotions is crucial for early social and emotional development. Decades of research have been devoted to studying how infants acquire emotion knowledge. Most of this work is based on a *prototype view*, which assumes that emotion categories have exemplars that share a typical or representative set of features (e.g., Ekman, 1992; Izard, 2007). Those proposed prototypic features, which include configurations of facial movements, are considered to be valid cues for the presence of a specific emotion in most circumstances. Due to the prominence of this view, almost all of the research on the early development of emotion understanding relies on infants' responses to photographs of adults posing stereotypical facial configurations (e.g., wide-eyed, gasping faces for 'fear'), each of which is assumed to depict the prototypic expression of a specific emotion category. In contrast, more recent theories of emotional development broadly emphasize that emotion categories are populations of variable, situation-specific instances that are conceptually based (Barrett, 2017; Hoemann et al., 2020). Despite widespread theorizing, surprisingly little research has investigated the *actual* faces that infants see and learn from as they are developing an understanding of emotion categories.

To address this gap in our understanding, the present study used existing videos wherein infants wore head-mounted video cameras during naturalistic 60-minute sessions at home with their family. Videos from 6 to 8 months (*N*=44) and 9 to 11 months (*N*=34) were coded. Whenever a full face was visible to the infant and close enough to see the whites of the eyes, the Facial Action Coding System (FACS;

Ekman, Friesen, & Hager, 2002) was used to code for facial muscle movements. In this way, we were able to objectively identify which facial configurations infants actually saw in their natural environments.

First, we examined how often the facial configurations that infants saw aligned with stereotypes corresponding to 18 different emotions (happiness, sadness, anger, interest, etc.). At both ages, the most frequently observed facial configurations (6-8 months: visible for an average of 41.2 seconds; 9-11 months: 45.1 seconds) did not match *any* of the emotion stereotypes. The next most frequently visible facial configuration was the happy stereotype (6-8 months: 25.1 seconds; 9-11 months: 20.8 seconds). Each of the 17 other emotion stereotypes was visible for fewer than 5 seconds on average across age groups. To assess consistency in the environment over developmental time, we also examined whether infant exposure to faces was correlated across our two developmental windows (6-8 months and 9-11 months). We found that infants who spent a greater proportion of time with full faces visible at 6-8 months also saw more full faces at 9-11 months ($r(34)=.497$, $p=.003$). However, there was no significant correlation across age groups in the amount of time spent seeing stereotypical positive ($r(34)=.110$, $p=.537$) or negative ($r(34)=.090$, $p=.611$) emotion faces.

These results support more recent theories of emotion understanding, suggesting that facial configurations often used in studies of emotional development may not be reflective of what infants typically see in real world interactions.

Abstract 3: Everyday Caregiver-Infant Communication is Shaped by Activity Context

Natural caregiver-infant communication is highly multidimensional and occurs across a variety of everyday routines and activities. Activity contexts have been shown to provide a source of consistency in input that supports infants' learning (Roy et al., 2015). However, while there is some evidence that context shapes caregivers' use of *speech* (e.g., Tamis-LeMonda et al., 2019), it is not known whether this contextual stability extends to other communicative dimensions. We examined caregivers' use of infant-directed communication (IDC) - the suite of communicative signals from caregivers to infants including *speech*, *action*, *gesture*, *emotion*, and *touch* - and assessed the degree to which caregivers' use of IDC was stable across contexts as well as across dyads.

We recruited 40 caregivers and their 18- to 30-month old infants (31 currently fully coded). These families were predominantly white, middle-class caregiver-infant dyads in the United States. Families were recorded a total of six times; during playtime, mealtime, and book sharing on two days. To capture these interactions during times at which they naturally occur, all videos were recorded asynchronously. Caregivers were emailed a personalized Zoom link, instructions, and example images indicating how to set up their camera to best capture each activity. Families simply clicked the Zoom link to record and a video file was automatically sent to our lab. Videos were coded for caregivers' use of each of the five dimensions of IDC (speech, action, gesture, emotion, and touch) using extensively detailed, previously-validated methods.

While most caregivers used all five dimensions of IDC during every interaction, the frequency with which each dimension was used varied across the three activity contexts, $F(8, 870) = 46.58$, $p < .001$. For example, during book sharing, caregivers' speech was especially high and action was low; during mealtime, variability increased for many dimensions (see Figure 1). We also found that both caregiver

identity and activity context promoted stability in caregivers' use of multimodal communication, $F(3, 8617.6) = 219.62$, $p < .001$ (see Figure 2). Specifically, IDC was most similar when it involved the same caregiver engaged in the same activity on two different days. But, when engaging in the same activity, even different caregivers used IDC in similar ways. However, IDC use varied markedly *across* activity contexts, regardless of whether the comparison involved the same caregiver or two different caregivers. Together, these results suggest that, while caregivers do provide a source of day-to-day stability in everyday communication, everyday contexts strongly shape caregivers' use of multidimensional communicative cues.

In sum, everyday activity contexts provide a source of structure and predictability in infants' multidimensional, real-world communicative input. Though controlled studies often focus on only one or two dimensions of communication, and frequently do not account for variation across contexts, these are both prevalent features of infants' actual learning environment. We conclude that rich characterizations of infants' everyday input both complement and enhance experimental approaches and are necessary for building ecologically-valid theories of learning and development.

Abstract 4: Cultural cascades: Effects of childrearing on motor skills, proficiency, and experiences

Developmental cascades—the reverberating effects of motor development on other developmental domains—has been studied predominantly in Western cultures where childrearing practices allow for free movement and exploration. These studies show that motor skills—manual, postural, and locomotor actions—allow for exploration, social interaction, and object play. Thus, these new forms of activity can instigate developments in domains such as perception, cognition, language and communication, and emotional expression.

To detect cascade effects, researchers have adopted a milestone approach, comparing differences in the onset age of new motor skills and its supposed effect in other domains. Milestones provide useful diagnostics for development, but do not represent the scope of motor development. Typically, researchers treat days since skill onset as a proxy for experience rather than actually measuring motor activities during everyday routines. Cultural differences in childrearing practices affect skill onset ages. Infants who receive special handling and exercise as part of typical childrearing routines achieve sitting and walking milestones earlier than infants who do not. Conversely, childrearing practices that restrict movement—back-sleeping, diapering—are associated with motor delays and less mature gait patterns.

Here, we study developmental cascades in a cultural context where childrearing practices differ from Western norms—within a culture that restricts movement—thereby testing whether movement is indeed central for development. In Tajikistan, caregivers use a gahvora cradle to sleep, toilet, and contain infants throughout the day. Infants are laid supine with their torso and limbs swaddled and bound. In previous work, we found that Tajik infants displayed later motor onset ages relative to WHO standards and prior-day cradling predicted walking proficiency. Lags in infancy were short-term: By 4-5 years of age, Tajik children's motor skills were comparable to U.S. norms.

In infancy, cultural childrearing affected walking proficiency; infants who spent fewer hours in the gahvora displayed more advanced walking compared to infants with more gahvora hours. To better understand this relation, we observed 104 16-24-month-old walkers during naturalistic 45-60-minute observations. We examined walkers' spontaneous locomotor exploration by scoring the number of elevations and ground surfaces walkers visited (e.g., gravel, mud, carpet, etc.) and the number of unique

surfaces encountered when infants were let loose from gahvoras. Preliminary data from 30 infants show that walking proficiency related to locomotor exploration (Fig1). Infants with more mature gait visited more ground surfaces and unique surfaces. This implies that childrearing practices may indirectly affect locomotor exploration; gahvora cradling may affect walking proficiency, which in turn affects infants' travel. Infants that explore more and different surfaces may have diverse, richer experiences practicing walking, regardless of onset age. In turn, richer experience advances walking skill. The extent of restrictive childrearing practices and its timing relative to skill onsets is important for shaping infants' opportunities to practice those skills by helping infants generate their own experience for skills to improve. The discontinuity and instability in Tajik children's experience over time—from movement restriction in infancy to freedom to move when locomotion is acquired—may be responsible for mitigating the short-term effects of cradling.

S.51 Learning in Uncertain Worlds: The Dynamics of Infant Brain and Behaviour in Response to Change

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Summary

Infants' brains and bodies are ever-changing. This change calls for adaptation: Infants must discontinue behaviours that no longer work, and adopt more effective ones. Here, we explore the behavioural and brain processes underlying infants' adaptation to change using convergent methods. The first work followed infants longitudinally using fNIRS to identify the brain correlates supporting response inhibition and its specialisation across infancy. The second talk uses a convergent method (fNIRS) to address a different aspect of adaptation to change–volatility estimation–showing that infants estimate volatility by recruiting the medial prefrontal cortex. The last talk uses a different method (Pupillometry) to address a convergent question. It shows that individual differences in infants' volatility estimation are stable traits that relate to temperament. By connecting different methods and paradigms, we offer new insights into the active role that infants play in adapting to change.

Details

Abstract 1, Mapping the neural correlates of inhibitory control from infancy to early childhood with functional near-infrared spectroscopy

Inhibitory control, a core executive function, develops rapidly across the first years of life. Although evidence supports the emergence of inhibitory control already in infancy, little is understood about its development across the early years of life. Less is known about the neural mechanisms that underpin this development, likely due to a lack of age-appropriate tasks and neuroimaging methods suitable for this population. Using functional near-infrared spectroscopy (fNIRS), an infant-friendly neuroimaging technique, alongside an age-appropriate response inhibition task (Holmboe et al., 2021), this longitudinal research aimed to localise the functional neural correlates of inhibitory control from infancy to early childhood.

Participants were tested at 10-months (N = 135; 70% White British, high socio-economic status), 16-months (N = 94) and 3½-years of age (N = 100). Based on previous research using this response inhibition task (Hendry et al., 2021; Holmboe et al., 2021), we hypothesised that participants would be significantly more accurate on prepotent trials (no inhibitory demand) than on inhibitory-demanding trials. With knowledge about the neural correlates of inhibitory control in older children (Mehnert et al., 2013) and adults (Aron et al., 2014), our fNIRS probe was designed to cover the bilateral prefrontal cortex (PFC) and intraparietal sulcus. However, due to a lack of existing infant studies, our first study with 10-month-olds made no hypotheses about the specific brain areas that may be associated with response inhibition (Fiske et al., 2022). Our second study (Fiske et al., under review) with the same cohort, now at 16-months, predicted that the same areas of the brain found at 10-months would be active when inhibition was required at 16-months. The third study with this cohort, now at 3½ years, hypothesised that the brain regions identified in infancy would continue to be recruited when inhibition was required in early childhood.

Behavioural results revealed that, at all ages, participants were significantly more accurate, and responded significantly faster, on trials with no inhibitory demand than on inhibitory trials. Longitudinal analyses indicated no change in response inhibition accuracy from 10- to 16-months ($F(1, 61) = .109$, $p = .743$, $\eta p2 = .002$), but significant improvements were observed for both accuracy ($F (2, 239.184) = 62.988$, $p< .001$, $\eta p2 = 0.345$) and reaction time ($F (1, 248.311) = 61.126$, $p < .001$, $\eta p2 = 0.198$) in early childhood.

fNIRS results (Table 1) revealed that inhibition at 10-months was supported by right-lateralised regions of the prefrontal (right DLPFC, right orbital PFC) and parietal cortices, whereas bilateral prefrontal regions (now including the IFG) and the left parietal regions support inhibition at 16-months, despite there being no performance improvement from 10- to 16-months. As such, the transition to toddlerhood may reflect an important developmental period of PFC reorganisation or specialisation. At 3½ years, a clear performance improvement was observed, yet some brain regions were consistently recruited by infants and young children alike, specifically the right inferior parietal cortex and right IFG. This consistent recruitment may suggest that these brain regions are fundamental neural indices of early inhibitory control.

Abstract 2, Evidence for adult-like responses to stable and volatile environments in infancy

The ability to recognise a changing environment is a fundamental aspect of cognition. Using fMRI, researchers have established that unexpected events cause a greater neuronal response than expected events within the anterior cingulate gyrus (ACC) and medial prefrontal cortex (mPFC) (Alexander and Brown, 2011; Schiffer et al., 2014). In the infant population, probabilistic associative learning has been investigated with fNIRS as fMRI is not currently suitable for awake-behaving infant research due to motion constraints. Unfortunately, fNIRS has poor spatial resolution, and the regions of interest tested are by necessity quite broad.

Our aim was to test the cortical responses related to probabilistic associative learning behaviours in infancy. Recent work using fNIRS has shown that the frontal lobe sends information about prediction-error to modulate the sensory cortices; however, these analyses involve looking at activation on the level of the full lobe rather than a specific region (Jaffe-Dax et al., 2020). High-density diffuse optical

tomography (HD-DOT) is an advanced form of fNIRS. HD-DOT has significantly improved spatial resolution due to overlapping multi-distance channels (Eggebrecht et al., 2012; Frijia et al., 2021). We employed LUMO, a HD-DOT system, to test how functional activation in the medial PFC was related to probabilistic associative learning (Gowerlabs Ltd.). Infant prediction responses were concurrently measured using gaze-tracking (Tobii Ltd.).

We employed a classic oddball design, where there was an auditory cue 100% of the time, but a cartoon character appeared just 80% of the time. Expected trials (A+V+) were contrasted against unexpected trials (A+V-). A similar fNIRS paradigm has been previously demonstrated to test associative learning within our age range of 6-8 months (Emberson et al., 2015). A final sample of 32 infants had sufficient data quality and trial numbers for both data types.

Gaze-tracking showed that the babies did make predictions and had significantly more exploratory behaviour for volatile compared to stable environment ($p < 0.001$). When the data were analysed using conventional methods, the reconstructed images showed an attenuated functional response in the frontal lobe for expected trials. When contrasted using more advanced statistical models, the differences in responses for unexpected compared to expected were confined to the mPFC (left mPFC U > E $p < 0.05$; right mPFC U > E $p < 0.01$).

Our results demonstrate that adult-like responses to a changing environment can be shown in infancy. Furthermore, the combination of gaze-tracking, HD-DOT, and more sophisticated modelling made it possible for us to demonstrate functional hemodynamic responses at the trial level using an ERP-style paradigm.

Abstract 3, Infants adjust their learning to environmental volatility: Underlying mechanisms and individual differences

Introduction. As infants develop, their perceptual, motor, and cognitive skills undergo a rapid transformation that keeps changing the way they experience the world. A central question arises: How do infants learn under these continuously changing conditions? In this paper, we employ a novel experimental paradigm and a computational modelling approach to identify the cognitive mechanisms supporting infants' ability to adapt to change.

Hypotheses. First, we hypothesise that infants are capable of actively adjusting their learning in response to environmental volatility, rather than being reactive to external events. This should be reflected in phasic pupil size tracking changes in volatility. Second, we predict that individual differences in volatility estimation emerge early in life and that they are related to the infants' broader psychological functioning. This should be reflected in a significant relationship between individual differences in volatility estimation and parental reports of infant temperament.

Population and Methods. Seven-month-old infants (N=70, Mean Age=7.2 months, SD=0.3, 38 females) were presented with a reversal-learning task in which two boxes were shown on the screen, and a target appeared from one of them (Fig.1A). The target has a high-likelihood location, in which it appears 90% of the times, and a low-likelihood location, in which it appears the remaining 10% of the times. The target location changes across trials, alternating stable and volatile phases. In stable phases, the high-likelihood

location is always the same (e.g., trials 1 to 18 in Fig.1B). In volatile phases, the high-likelihood location changes (e.g., trials 19 to 38). The Volatile Kalman Filter (VKF) is a computational model that tracks trial-by-trial changes in volatility and predicts the most likely target location accordingly (Fig.2B). We related infants' phasic pupil size and preferential looking to the estimates of the VKF to infer their underlying ability to track volatility. After the testing, parents filled out the short form of the Infant Behavior Questionnaire (IBQ).

Results. Infants' tonic pupil dilation was related to the VKF's estimates of volatility (Fig.1C), indicating that infants were successfully tracking whether the environment was stable or volatile ($t=139.56$, $\beta=.57$, $p<0.001$). Moreover, this ability allowed infants to correctly adjust their predictions about the target location (Fig.1D), as indexed by the significant relation between preferential looking and the VKF's estimates of the most likely target location ($t=3.78$, $\beta=1.68$, $p<0.001$). Finally, we found that individual differences in volatility estimation predicted the scores of the Fear ($t=2.97$, $\beta=0.48$, $p=0.005$) and Sadness ($t=2.51$, $\beta=0.41$, $p=0.018$) subscales of the IBQ.
Together, these results identify the cognitive processes underlying infants' ability to adapt to change, and show that individual differences in this fundamental learning mechanism relate to their temperament. This opens to new avenues for identifying early-risk factors and learning difficulties that might impact later cognitive development and psychosocial well-being.

S.52 Neural Entrainment as a Gateway to Understanding Infants' Learning skills

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Summary

The symposium aims to present and discuss recent evidence on neural entrainment and its application in studying infants' learning skills. Study 1 investigates the effect of temporal variation of rhythmic visual sequences in modulating endogenous neural oscillations. Studies 2, 3, and 4 exploit the idea that rhythm-induced modulation provides a window to understand the neural processes underlying the ability to learn patterns. Specifically, study 2 explores neural entrainment in response to visual repetition-based rules in infants and adults. Studies 3 and 4 investigate neural entrainment in tracking statistical regularities from visual (study 3) and across multiple features of speech sequences (study 4) in infants and newborns. Overall, this symposium highlights the usefulness of neural entrainment to understand further how individuals develop their abilities to perceive and extract structural information, enriching our knowledge of the development of perceptual and learning skills.

Details

Abstract 1: Resonance Phenomena in Response to Rhythmic Visual Stimulation in the Infant Brain

The present study extends findings on resonance phenomena from the adult literature to the infant brain. In his landmark paper, Hermann (2001) applied rhythmic visual stimulation at different frequencies (1-100Hz, 1Hz steps) to adult participants. In addition to a rhythmic brain response at the base frequencies and their harmonics (for most stimulation frequencies), results showed a consistent resonance phenomenon at the 10Hz alpha frequency. That is, the visual cortex response increased at 10Hz

independent of the stimulation frequency. Although there is increasing interest in the development of neural oscillations and resonance phenomena in the infant years, there is currently a lack of research exploring whether such a general alpha resonance phenomenon can similarly be found in the infant's brain. Our study is designed to address this gap. Furthermore, given the importance that previous studies attribute to the theta frequency range in infants' information processing, we examine to what extent resonance phenomena can be observed in the ~4Hz theta range. We applied rhythmic visual stimulation in different frequencies to 7- to 9-month-olds while recording their EEG. Infants were presented with images of cartoon monsters (depicted in Figure 1) that were flicked sinusoidally at eight frequencies: 2, 4, 6, 8, 10, 15, 20, and 30Hz. Each image was presented for two seconds, and each frequency was shown up to 75 times in a randomized order sequence. Non-flickering control trials were also presented. We used a Fast Fourier Transform to examine the different response patterns to the various stimulation frequencies. Figure 2 shows the preliminary results from the first nine infants (the data from 50 infants is now assessed and will be presented at the conference). The results show a rhythmic brain response at the base frequency for all frequencies except 20Hz. Moreover, we found an increased response at harmonics of these base frequencies for a subset of the stimulation frequencies. However, unlike in adult studies, we did not find a resonance phenomenon at the ~10Hz alpha frequency. Instead, results pointed towards such resonance phenomenon at the ~4Hz theta rhythm: infants' cortical response increased in the ~4Hz theta frequency, independent of the stimulation frequency. Our preliminary findings support the important role of the theta frequency band in infants' information processing. This aligns with previous studies showing that theta is the dominant oscillation in young children and is involved in the building of visual representations in infants. However, our results stand in contrast to the results of adult literature, which show a clear resonance phenomenon at alpha. The results will be discussed in the light of different hypotheses on the functional relevance of theta and alpha in the infant and adult brain.

Abstract 2: **Visual rule learning in preverbal infants and adults: evidence from neural entrainment**

Visual Rule Learning (RL) is a key cognitive ability available early in development that allows the detection and generalization of repetition-based rules embedded in a continuous stream of items (Marcus et al., 1999). Most of the studies investigating infants' RL skills rely on the habituation procedure, in which participants are exposed to item sequences instantiating a rule (ABA/ABB), and looking times are measured during post-habituation test trials with new items instantiating the familiar and a novel rule (e.g., Ferguson et al., 2018). This approach does not allow the learning process itself to be investigated, and individual and cross-age differences in RL skills to be traced. One way to investigate the temporal dynamics of the RL process is by exploiting neural entrainment (Choi et al., 2020), the phenomenon by which brain activity naturally synchronizes to the rhythm of external periodic stimuli (e.g., Norcia et al., 2015). To date, neural entrainment has been exploited to investigate statistical learning in the auditory modality (e.g., Choi et al., 2020; Kabdebon et al.,2015). Here, we measured neural entrainment to rule-like structures embedded in sequence of visual items in infants and adults. Thirty-three adults (25 females) and 31 9-month-old infants (15 females) were exposed to triplets of shapes organized into ABA structure for 2 minutes. Each shape was presented at a frequency of 6 Hz, while the frequency of triplets was 2 Hz (Figure 1). To explore learning dynamics, the first epoch was split into segments of 10 sec each, containing 20 reiterations of the rule, and the EEG signal was analyzed at occipital electrodes in the frequency domain. For both age groups, Z-scores at occipital clusters were significantly higher than noise at the shape (6 Hz) and the triplet (2 Hz) frequencies already during the first 10 seconds of stimulation (Z-scores > 2.33). The time x age group ANOVAs revealed that EEG response strength at both 6 Hz and 2 Hz was greater in infants than in adults ($p < .001$). At 6 Hz, a Time x Age Group interaction ($p < .007$) showed that the age group effect was present only during the first minute of stimulation ($p < .001$), but not during the

second minute (p > .352). At 2 Hz, the interaction was nonsignificant (p > .127; Figure 1). These results indicate that infants entrained more strongly than adults across the entire stimulation duration at the triplet level but only during the first minute at the shape level. Overall, our results suggest for the first time an infant's learning advantage in abstracting patterns embedded in sensory stimulation. This study provides evidence that infants are equipped with a general rule-learning mechanism that makes them particularly able to learn novel structures under passive exposure and may facilitate the development of more complex cognitive skills.

Abstract 3: **Exploring neural entrainment to visual statistical regularities in the infant brain**

Visual statistical learning (VSL) refers to the ability of becoming sensitive to the visual regularities in our environment. This skill facilitates the detection of structure and emerges very early in development (Bulf et al., 2011; Kirkham et al., 2002). Thus far, developmental research has mostly investigated VSL with post-exposure behavioural tasks that only reveal the outcome of learning. Notably, behavioural tasks may lead to ambiguous interpretations since there is no clear consensus about the directionality of the expected learning outcome (i.e., novelty vs. familiarity effect). Steady-state visual evoked potentials (SSVEPs) can be acquired while learning occurs and can shed light onto the temporal course of learning. At present, SSVEPs investigations of the ongoing learning processes have been limited to the auditory domain (Choi et al., 2020). In this study, we used SSVEPs to investigate infants' neural entrainment mechanisms in response to visual regularities. The final sample included 30 4- to 6-month-old infants (11 females, M age = 156.5 days). Participants were presented with 20s blocks of 8 colourful shapes appearing in the centre of the screen at a frequency of 6 Hz. These blocks were alternated with attention-getting animations to attract the infant attention to the screen. Participants were randomly assigned to one of three conditions: 1) the standard doublet condition, in which the 8 shapes were organised in 4 doublets, 2) the control doublet condition, in which 4 shapes could take the first position of the doublet and other 4 shapes the second position of the doublet, leading in turn to 16 possible doublets, and 3) the random condition, in which individual shapes were randomly presented. We compared the signal-to-noise ratio (SNR) at the base frequency of visual stimulation (6 Hz and its higher harmonics) and at the frequency of doublet presentation (3 Hz and its higher harmonics) across conditions. As long as participants were attending to the visual stimuli, we hypothesised a peak at the base frequency of visual stimulation across occipital channels in all conditions. At the same time, if the sequence included a regular organization in doublets, we hypothesised a progressive response at 3 Hz. Linear mixed-effects models revealed that the SNR at the base frequency was only explained by trial order, with a decreased SNR over time. Hence, neural entrainment at the base frequency did not differ across conditions. This confirmed that infants attended similarly to the visual stream of stimuli, independently of the condition. On the other side, activity at the doublet frequency was only explained by condition. In particular, the SNR at the doublet frequency and its harmonics was higher in the standard doublet condition compared to the random condition. This showed that the infant brain is sensitive to a regular doublet organization, especially in the standard doublet condition. Overall, these findings provide an early neural signature of VSL abilities and are crucial to better understand learning mechanisms as they unfold during stimulus exposure.

Abstract 4: Statistical learning across multiple features of speech at birth

Statistical learning (SL) is crucial for language acquisition in human infants. However, SL is ubiquitous across species and domains (Santolin et al., 2018; Saffran et al., 1999; Fiser et al., 2002; Kirkham et al., 2002), prompting the importance of the articulations of SL with other processes and how it operates across different input dimensions. In a previous study using electroencephalography and neural

entrainment, we showed that sleeping neonates track the regularities and extract words from a stream formed by four randomly concatenated trisyllabic words (Flo et al., 2022), revealing that from birth, infants statistically analyze the linguistic input they receive. The current study investigates whether SL is limited at birth to phonetic regularities or operates as well on an essential but non-linguistic dimension of speech, namely, voices. We exposed neonates to artificial languages constructed by concatenating syllables simultaneously varying in their phonetic content and the voice uttering them (i.e., pitch and timbre). We used six consonant-vowel syllables produced by six voices (36 possible tokens). The experiments included (1) a Random stream with phonetic and voice content varying randomly, (2) a Structured stream built by concatenating three bi-syllabic items defined by the transition probabilities between the phonemes (voices), while the voices (phonemes) varied randomly, (3) isolated duplets adhering or not to the structure. In Experiment 1 (N=33), the Structured stream had regularities based on the phonetic content. In Experiment 2 (N=32), the Structured stream had regularities on the voices. Notice that the duplets presented in the two experiments were identical; thus, any effect must be due to the familiarization. During the experiment, we recorded high-density EEG (128 electrodes). We observed neural entrainment at the frequency of the regularity (2 Hz) with comparable activation patterns for both familiarization streams (inter-trial-coherence bigger than at adjacent frequency bins, $p < 0.05$, one-sided t-test, FDR corrected) (Fig 1). Significant neural entrainment at 2 Hz emerged in both experiments at around 2 min after the onset of the familiarization stream. After familiarization, the event-related potentials (ERP) to correct (words) and incorrect (part-words) duplets differ in both experiments (cluster-based permutation analysis, $p<0.05$) (Fig 2A-B). Additionally, we found an ERP component consistent with an N400 only for Experiment 1 duplets (cluster-based permutation analysis, $p<0.05$) (Fig 2C). The entrainment at 2 Hz and the difference in ERPs between words and part-words show that neonates are equally sensitive to regularities based on phonetic or voice dimensions of speech, even in the presence of a non-informative feature, revealing that neonates have a powerful tool to create associations between recurrent events on probably all dimensions in which stimuli are factorized in the auditory cortex. The lack of advantage for the linguistic dimension points to the universality of statistical learning mechanisms. Based on the ERP component found only after familiarization with an artificial language with structure over the phonetic content, we hypothesize that phonetic regularities might provide lexical entries. Thus, the language networks might get differently involved depending on the regularity dimension.

S.53 Tuning in to the Context: Unraveling the Multifaceted Aspects of Early Vocal Development

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Summary

Infants' vocal development is dynamic, but not fully understood. Our broad approach, spanning infant primates, explores how body, context, and social factors shape communication. First, we reveal that infant walking onset boosts object exploration and alters vocal production, with vocalizations peaking before and after walking begins but stabilizing during the transition. Second, we find that in 9–24-month-olds, greater body stability, reduced hand and head movement, relates to longer vocalizations. Next, we demonstrate that infants' vocalizations and conversational turns become context-dependent from 9 months of age, despite earlier differences in parents' input. Finally, we show how parental feedback influences marmosets' vocal types and contexts, mirroring vocal evolution across primates.

This symposium presents a holistic view of early vocal development, emphasizing its nonlinearity, environmental interaction, and the need for interdisciplinary study.

Details

Abstract 1 Title: Walk, talk, play: Learning to walk changes how infants communicate and play with objects

With each passing day, infants learn skills that enable new ways to explore the environment and interact with social partners. Research suggests that the transition to walking shapes how infants communicate and play with objects. Compared to pre-walkers, walking infants spend more time moving, vocalize more frequently, and are more likely to retrieve distal objects. Existing knowledge about these connections, however, is primarily drawn from cross-sectional or longitudinal investigations that group infants by chronological age or locomotor status. But development unfolds in-the-moment, and infants must learn to integrate skills simultaneously—they walk, talk, and play. Here we address this question of co-developing skills by following infants longitudinally and modelling change in object engagement and vocalization as infants learn to walk.

We videorecorded 51 infants monthly at home during everyday activities with caregivers for 30 minutes. Data were anchored to walk onset (the day when infants first took five independent steps without stopping or falling; M_{age} = 12.92 months, *SD* = 1.97). In total, sessions spanned the 100 days before to 100 days after walk onset, and all infants contributed at least two sessions (*M* = 5.71, *SD* = 1.36). Coders identified all times when infants touched objects with their hands and whether the objects were distal (i.e., infants locomoted to the object within 5 s prior to contact). Coders also identified all infant vocalizations in a preliminary sample of 21 infants. We calculated the *rate of object touches*, the percentage of object touches that were *distal*, and the *rate of vocalizations*.

We fitted a series of mixed-effects models to assess the shape of change for each behavior across the transition to walking. The rate of object touches increased quadratically over time (R^2 = 0.385), with growth slowing as infants gained walking experience (Figure 1a). Infant contact with objects that were distal, however, increased steadily across the 200-day timeframe, and was best represented with a linear model (R^2 = 0.215; Figure 1b). By contrast, growth in infant vocalization was best represented by a cubic model (R^2 = 0.395). As shown Figure 2, infants demonstrated steady growth in vocalization across the 100 days leading up to walk onset; but around walk onset, their growth plateaued for a brief period of time before resuming across the rest of the observation period. In fact, examination of data from individual infants showed that 61.9% of infants demonstrated a brief *decrease* in vocalization between their last pre-walking session and first walking session (*n* = 9) or between their first and second walking sessions (*n* = 7).

Taken together, our detailed account of infant behavior indicates that the transition to walking shapes infant communication and object play in different ways. Infant engagement with objects and contact with distal objects increased as infants gained locomotor skills. But growth in infant communication slowed around the emergence of walking. Thus, while learning to walk may create new opportunities for learning, there may also be behavioral trade-offs at the onset of new skills.

Abstract 2 Title: Body movements can shape the length of infant vocalizations

Vocal production plays a critical role in infants' motor development. Incidental movements and actions induce short grunt vocalizations in early infancy, providing an early training ground for the vocal tract to produce sounds (McCune, 2021). As infants develop their motor skills, they exhibit rhythmic arm movements when producing sounds (Thelen, 1979), leading to canonical babbling (Iverson & Fagan, 2004), a precursor to word production. At 9 to 24 months of age, when infants increasingly produce recognizable words, both head and hand movements co-occur and become more temporally coordinated with vocalizations (Borjon et al, In Press). The present study sought to determine, in real-time, how infants' head and hand movements before, during, and after producing sounds could shape vocalizations, and how these dynamics may change based on vocalization length. Findings demonstrate that vocalization duration is related to changes in head and hand movement.

44 unique infants emitted a total of 2,641 vocalizations across 128 sessions during free play. Infants were 9 to 24 months of age and binned into two groups: younger infants (9-15 months) and older infants (18-24 months). Rotational movement velocity was measured using motion capture sensors affixed to infants' heads and back of both hands. The average of the left- and right-hand velocity was calculated to represent overall hand movement. Change in velocity around a vocalization was calculated by taking the median velocity before, during, and after a vocalization. The before and after periods were each equal in duration to the vocalization.

Movement patterns were calculated by plotting velocity changes before and after vocalizations for the hands and head. Each quadrant represents a different shape. Points closer to the center indicate less change. For both younger and older infants, the less change in hand and head movement around a vocalization, the longer the vocalizations an infant can produce (LME, main effect of movement pattern change on vocalization duration for both the hands $F(1,2639) = 6.9478$, $p < 0.009$ and head $F(1,2639) = 23.548$, $p < 0.0001$).

For younger infants, increasing acceleration in hand (Spearman $r = 0.126$, $p = 0.036$) and head (Spearman $r = -0.146$, $p = 0.019$) movements before vocalizing is also positively correlated with longer vocalizations, a relationship that vanishes in the older infants. For older infants, the less deceleration in hand (Spearman $r = 0.102$, $p < 0.002$) and head (Spearman $r = 0.0134$, $p < 0.0002$) movements leading into a vocalization, the shorter its duration.

Longer vocalizations likely require a more stable body to coordinate the muscles necessary to produce a sound. For the younger infants, 9-15 months of age, long vocalizations are also associated with increasing hand and head movement acceleration before vocalizing, while older infants, 18-24 months of age, do not show this correlation. Future analyses will relate movement changes to the range of infants' vocal sounds. Understanding the interplay between infants' body movements and vocalizations can shed light on developmental milestones, trajectories, and early detection of developmental disorders.

Abstract 3 Title: Babbling and conversing about toys: Infant vocalizations and conversational turns become task-dependent by the end of the first year

Language development happens in the context of social exchanges as infants actively participate in conversation-like vocal turn-taking from a very early age. But conversations are not only situated socially - they are also happening in a particular *situational* context. However, when do infants start to

differentiate between situational contexts? Or, in other words, when do protoconversations become context-specific?

In this study, we investigated whether early vocal communication (frequency of infant vocalizations, frequency of parental speech, number of conversational turns) differs between three types of infant-parent games (book-sharing, rattle-shaking, and play with manipulative toys, each 5 min long) across the first year of an infant's life. The infant-parent interactions were video-recorded longitudinally (N=104) in the lab across the first year of an infant's life (visits at 4-, 6-, 9- and 12- months of age). Infants' speech-like vocalizations and parental speech were coded offline, and the rate per minute of vocalizations as well as the number of conversational turns, was calculated. The General Estimating Equations (GEE) with age (4) and game (3) as within-subjects factors were used to assess the longitudinal changes in all variables.

In the rate per minute of infants' vocalizations, we observed the effects of the game (Wald $\chi2(2) = 6.270$, $p = .044$) and time point (Wald $\chi2\ (3) = 33.947$, $p < .001$), as well as the interaction effect (Wald $\chi2\ (6) = 32.256$, $p < .001$). Infants vocalized more during book-sharing than during play with manipulative toys at 12 months, but at 4, 6, and 9 months there were no game-related differences. In the rate per minute of parent speech, we observed a main effect of the game (Wald $\chi2\ (2) = 301.697$, $p = .001$) and time point (Wald $\chi2(3) = 57.769$, $p < .001$). Parents were speaking more frequently during the book-sharing game than during the other two games. In the number of conversational turns, we observed the main effects of age (Wald $\chi2(3) = 37.959$, $p < 0.001$) and game (Wald $\chi2\ (2) = 784.069$, $p < .001$) as well as interaction effect (Wald $\chi2(6) = 45.028$, $p < .001$). At 9 and 12 months, there were more conversational turns during book-sharing than play with manipulative toys and rattle-shaking. At 12 months, there were also more conversational turns during rattle-shaking than play with manipulative toys. There were no significant game differences at the first two time points.

Overall, our results show that infants' vocalizations become context-dependent only in the second half of the first year of life - despite consistent game-related differences in parents' verbal input from the age of 4 months. Interestingly, the number of conversational turns (a measure of dyadic communication) also becomes context-dependent by the end of the first year. This suggests that infants need time and experience to become conversational partners.

Abstract 4 Title: Parental feedback shapes vocal development in marmoset monkeys

In contrast to human speech development, primate vocalizations are believed to undergo minimal developmental changes, with almost no role of parents in their vocal development. This apparent evolutionary discontinuity generated several theories on the origin of human communicative capacity. We recently revised this widely held assumption by showing that marmoset monkeys, a cooperative breeding New World primate, have vocal development guided by parental feedback, similar to what we observe in humans. However, the evidence of vocal plasticity was limited to a single behavioral context. Therefore, the extent to which the vocal development in marmosets is similar to that of humans is still unknown. Here, we tested whether marmosets learn to produce different vocalizations in different contexts through social interactions. We focused on two very distinct vocalizations that marmosets produce in distinct contexts: long-distance contact calls, produced when the animals are out-of-sight from each other, and short-distance contact calls, produced when the animals are in visible distance.

We recorded the vocalizations of nine infant marmosets from postnatal day seven to postnatal day eighty. Each marmoset infant was exposed to playback of long-distance/short-distance contact calls for five/five minutes daily, contingent on infant vocalization. When the marmoset infants were not receiving playbacks, they were with their families. Simulating the expected association between social context and vocal type, four marmosets received contingent short-distance contact call playback in the presence of a doll, mimicking an adult marmoset, and long-distance call playback in the absence of the doll (control group). Five other marmoset infants received contingent playback in switched social contexts (switched group). We hypothesize that the infants that received playback in switched social contexts would learn to produce shorter contact calls without a visible marmoset/doll.

We observed that the proportion of short-distance contact calls in the absence of visual stimuli in the switched group (proportion ± standard error, 0.57 ± 0.02) was significantly larger than in control (0.24 ± 0.03, chi-squared test, $p < 0.001$). We also observed that the duration of short-distance calls produced by infants was shorter in the switched group (mean ± standard error, 363.4 ± 18.1ms) compared to the control (494.6 ± 46.4ms, rank-sum test, $p < 0.001$).

Our results show that context-dependent contingent vocal feedback modulates infant marmoset vocalization, indicating that marmoset monkey vocalization exhibits larger flexibility than previously thought. Furthermore, our results support the hypothesis that marmosets and humans' vocal communications are examples of evolutionary convergent behaviors, possibly due to their unique cooperative breeding systems.

S.54 Exploring Affective Touch in Infant Development: Contextual Influences, Ecological Patterns, and Clinical Innovations

Anna Madden-Rusnak [1], **Martine Van Puyvelde** [2], **Louise Staring** [2], **Laura Mulligan** [3]

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Summary

Touch is essential for healthy development and known to have positive outcomes for infants like improved regulation and pain relief. It's hypothesized these benefits emerge from touch facilitating activation of an infant's regulatory nervous system. However, most work on this topic has been conducted in hospital settings or tightly constrained experiments, and questions regarding both the specificity and generalizability of these results remain open. Our first two talks deepen our knowledge of touch mechanisms by incorporating more rigorous controls and ecologically valid contexts into infant touch research. The third talk leverages established findings to motivate and pilot a clinical device to provide NICU infants "touch" – presenting a model to test whether touch effects generalize to *machine* contact. Our Discussant will cover how our diverse paradigms and results converge to further our understanding of affective touch in infant development.

Details

Abstract 1, Title: Abstract 1, Tiny shifts, major ripples. The sensitivity of infant's physiology to contextual changes in experimental paradigms.

Affective touch is widely recognised as crucial for the healthy development of infants. This is evidenced by the far-reaching role of C-Tactile afferents, an essential subclass of unmyelinated low-threshold mechano-sensitive skin fibers that conduct affective information about gentle interpersonal touch (McGlone et al., 2014). However, studying infants is challenging and standardized laboratory studies often require a more flexible and ecologically valid setting. However, various contextual factors may confound results. For instance, the use of oil might enhance the effects of affective touch (Field et al., 1996). Additionally, changes in the parents' behaviors, such as engaging in other movement or activity while interacting with their infant, may cause metabolic changes which affect either of their cardiorespiratory parameters. Our prior work found that 3-min maternal gentle stroking touch increased infant parasympathetic activity, relative to a pre-stroking no-touch resting baseline (Authors, 2019). The aim of this current study was to test how manipulating mother's movements during active no-touch baselines pre and post 3-minute stroking touch, as well as stroking with or without oil, may influence mother-infant cardiorespiratory parameters.

Methods. We tested the effect of a 3-min stroking touch period on mother-infant physiological regulation relative to active no-touch baselines pre and post stroking touch. The goal of these active baselines was to stabilize the mother's metabolic activity, by asking them to stroke a pillow. Throughout the entire experiment mothers held their baby horizontally, but away from their chest, to control for vestibular proprioceptive effects. We also tested the physiological effects of using oil during stroking touch by conducting the experiment twice within each dyad on two consecutive days, once with and once without oil (counterbalanced). Electrocardiogram (ECG) and respiration of 21 mother-infant dyads (infants aged 5-14 weeks) were measured to calculate RR-intervals (RRI), respiration rates (fR) and respiratory sinus arrhythmia (RSA).

Results. Infants' RSA significantly increased during the post-stroking active baseline, but not during the stroking touch period, indicating a delayed effect of stroking touch on infant cardio respiration. The use or omission of oil did not influence infant cardio respiration.

Conclusion. Prior work with resting no-touch baselines pre and post stroking touch found that infant RSA increased during stroking touch, and continued increasing after. The delay we observed may be attributed to infants acclimating to mothers' continued movement. These results underscore the impact of experimental manipulations and the need for ecological designs when studying parent-infant populations.

Next Steps. Expanding on these insights, we will also present methods and preliminary results for an ongoing project "Sensitouch", which investigates the impact of the parental context on infant affective touch sensitivity. Existing research relies on retrospective, cross-sectional, and laboratory studies in the infant, the mother, or at best the mother-infant dyad. This project takes a novel approach by prospectively examining affective touch sensitivity (CT-sensitivity) in infants in the first six months of life within the broad parental context. The goal is to achieve a triadic understanding of CT-sensitivity development in early life, thereby better discerning associated risk and protective factors, ultimately enhancing prevention and intervention efforts.

Abstract 2, Title: Abstract 2, Brief and close to the heart: Exploring ecologically valid patterns of dyadic close physical contact and their real-time influences on infant physiological regulation.

Close physical contact between infants and their caregivers is known to facilitate real-time regulation and predict infant self-regulation, maternal sensitivity, and infant-caregiver attachment outcomes (Anisfeld et al., 1990; Bystrova et al., 2009). The underlying mechanism behind this relationship is theorized to be the regulation of infant physiology via caregiver physical contact (Lenora, 2010; Norholt, 2020). Specifically, prior work has shown that touch increases infant parasympathetic activity, thought to reflect a restorative physiological state (Van Puyvelde et al., 2019). However, we know little about close physical contact behaviors in everyday settings where caregivers and infants spend the majority of their time nor their influences on real-time infant physiological regulation. This gap is critical given that close physical contact behaviors in standardized laboratory situations may not represent more ecologically valid interactions. Thus, to gain insight into ecologically valid biobehavioral mechanisms that promote positive socio-emotional development, we 1) provide a detailed descriptive account of everyday close physical contact behaviors and 2) the real-time impacts of these close physical contact behaviors on infant real-time physiological regulation.

Method. N=28 mother-infant dyads participated in a 60-minute video-recorded home observation while wearing chest-mounted ECG sensors (1024 Hz). Infants were 4.68 months on average (SD = 2.34, Range: 1.13-10.60 mos.), 54% female, and mostly Non-Hispanic White (54%) or Hispanic (32%). Using video recordings, we annotated all instances of close physical contact (holding and carrying), detailing the nature of contact when the infant is in contact with the mother's chest (infant side/back/chest to mother's chest), and when the infant is not in contact with mothers chest (held in lap/held away from body). Within these events, we annotated the presence of active touch or movement (stroking, patting, bouncing).

Contact Behavior Descriptives. We observed n=844 unique close physical contact events, 39.8 close physical contact events per hour (SD = 24.69; Range: 11-100 events). These events ranged from 1 second to 24 minutes, (M= 28.8 s). Mothers held their infants chest-to-chest for the majority (88.3%) of contact events, and only 29.6% of contact events included active touch from caregivers, indicating that passive contact is more common in everyday dyadic close physical contact. Overall, we conclude that physical contact behaviors are frequent in everyday interactions, and typically much shorter than those examined in standardized experiments.

Physiological analysis plan. In prior work, we demonstrated that dynamic RSA (5Hz) can be used to access real-time processes of regulation in everyday, unstructured infant behavior (Authors, 2023). Before the 2024 ICIS conference, we will utilize these existing pipelines to examine RSA changes following close physical contact events to test the following hypotheses: 1) close physical contact increases infant RSA compared to periods of no close physical contact, 2) within close physical contact events, active soothing touch increases infant RSA greater than passive touch, and 3) within active/soothing physical touch events, active soothing touch during chest-to-chest contact has the strongest increase of infant RSA compared to active soothing touch during other contact events.

Abstract 3, Title: Abstract 3, Evaluating the " C-Tactile Stimulator" as a Substitutional, Non-Invasive Device to Enhance Physiological Regulation in Preterm Infants in the NICU.

Globally, 15 million preterm neonates annually survive to adulthood, with 85% reporting ongoing concerns related to prematurity (Williams & Tann, 2019). Medical advances have greatly improved survival rates and outcomes of infants born preterm however, lifelong neurodevelopmental disabilities are still common. Research suggests that maintaining caregiver-infant proximity mitigates stress and

promotes optimal neurodevelopment (Bigelow & Williams, 2020). Though the benefits of skin-to-skin contact are well recognised in clinical practice, while in the NICU, preterm infants often experience reduced tactile interaction depriving them of the physiological benefits afforded by such nurturing care. Thus targeted, cost-effective interventions that support typical neurodevelopment and improve long-term outcomes are required.

A specific population of unmyelinated, sensory nerve fibres have been identified to respond optimally to low velocity (gentle) stroking touch. These C-tactile (CT) afferents are hypothesised to play a key role in facilitating the beneficial effects of nurturing touch (McGlone et al., 2014). Recent investigations have shown that 5 minutes of dynamic touch, delivered at a CT optimal velocity, reduces heart rate and increases blood oxygenation saturation in infants born preterm, while static touch in these standardized conditions did not (Manzotti et al., 2019; Croy et al., 2022). These results suggest potential neurodevelopmental benefits for preterm infants in particular.

The Current Study. We hypothesise that the regular delivery of CT optimal dynamic stimulation to preterm infants in the NICU could mitigate some of the adverse neurodevelopmental consequences of preterm birth. To this end, a prototype massaging device (Figure 1) has been designed that can be placed under an infant in a standard incubator, (see device details below). A prior study previously identified the settings which best replicate the sensation of a CT optimal, dynamic stroking touch (Authors, 2019).

Sample. N=12 well infants (born between 34 and 42 weeks) at Liverpool Women's Hospital (LWH), a tertiary-level maternity and neonatal unit handling over 8000 births annually.

Procedure. Our clinical acceptability evaluation involves measuring the physiological and behavioural responses of healthy newborns being placed on the device. Video recordings capturing infant behaviours during this procedure will be coded using Operational Definitions of Stress Behaviours (Peng et al., 2013) to systematically assess tolerance. Additionally, we are conducting voice-recorded interviews with clinicians and parents to assess the acceptability of employing the device in a clinical setting.

Device. The C-Tactile Stimulator (CTS) device (see Figure 1) is composed of a series of silicone rubber tubes arranged side by side, designed for sequential inflation and deflation to emulate dynamic caressing touch. The device is adaptable to any standard neonatal cot mattress and can be covered with standard NICU cot sheets to provide a non-frictional stroking sensation, minimising the risk of friction-related skin damage.

Outcomes. Physiological, behavioural, and qualitative results will be collected and analyzed before the ICIS 2024 conference. Results of this study will inform future trials to assess the device's efficacy in enhancing physiological regulation with the potential to improve neurodevelopmental outcomes in infants born preterm. This study also highlights the translational utility of affective touch research in real-world clinical applications.

S.55 Analysing Vocal Contingency in Parent-Infant Interactions: Consistency and Variability Across Contexts and Development

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Summary

Vocal Contingency, the synchronized temporal alignment in the vocal behaviour of interacting partners, is crucial for infants' development of language (Goldstein, 2003), attention (Mason et al., 2019), and socio-emotional skills (Gordon et al., 2010). Despite consensus on the importance of parental contingent behaviours, the mechanisms through which social contingency influences infants' developmental trajectories are understudied. This symposium proposal involved three studies using the same automated vocalisation classifier (Lavechin et al., 2021) and similar permutation analyses to eliminate spurious findings. It will examine contingency patterns through a consistent pipeline across diverse contexts, analysing interactions in Italian and English-speakers, including triadic and dyadic scenarios, tabletop lab interactions, and daylong home contexts. Results reveal consistent patterns during dyadic free play; divergences are observed when the context and interaction-structure differs.

Details

Abstract 1, Title: Parents' and infant's vocal contingency during dyadic and triadic interactions.

Infants' development is known to be facilitated by parental contingent behaviours, even if little is known about the mechanisms through which social contingency influences development (Gordon & Feldman 2010, Feldman, 2007; Goldstein et al, 2003, 2008). Research on infants' social contingency has focused mainly on dyadic aspects of the mother-infant or, more rarely, the father–infant interaction (Provenzi et al., 2018; Lamb, 2010). Moreover, few studies addressed family functioning at a microanalytic level taking into account a real triadic level, rather than the various subsystems (Cox & Paley, 1997; Feldman, 2007, Gordon & Feldman 2008). This study aimed at investigating the vocal contingency patterns during dyadic and triadic interactions (mother–father–infant) through a semi-structured procedure. Vocal contingency was defined as a vocalisation occurring within 2 sec from the offset of the previous partner vocalisation (Goldstain & Schwade 2008). Preliminary results on a sample of 30 triads with 4-month-old infants indicate that parents' vocal contingency rate to their babies is comparable, despite mothers' number of vocalizations being greater than fathers' during both dyadic ($p < .01$) and triadic ($p < .01$) interactions. Infants' contingent vocalisations to mothers and fathers are also comparable during dyadic interactions. Crucially, during triadic interactions, infants' vocalisation rates increase overall, compared with dyadic, but become less contingent on both caregivers ($p < .01$). In addition, during the triadic interaction, the likelihood of a caregiver vocalizing contingently towards the infant increases ($p < .01$). In future analyses we shall explore the fine-grained time dynamics that drive these differences in vocalization rates and contingency between dyadic and triadic interactions. Globally, our results bring evidence of an early, but not fully developed, capacity of the infant to deal with triangular interactions. Although being more challenging, triadic contexts are important learning fields that prepare the ground for the intentional stance.

Abstract 2, Title: Does Child-Caregiver Vocal Contingency Change as a Consequence of Interaction Type? A Longitudinal Study Comparing Interpersonal Contingencies of Table-Top Play

Social Contingency, i.e. behaviour that temporally aligns with the behaviour of an interacting partner, is an influential factor in many facets of child development. Previous research has highlighted the influence of parental contingency on affective, cognitive, and language development, as well as the

quality of parent-child attachment (Blehar, Lieberman, & Ainsworth, 1977; Stern, 1985; Dunham & Dunham, 1990; Goldstein & Schwade, 2008).

Many studies looking at vocal contingency have predominantly employed designs featuring smaller sized datasets with manual hand-coding (Goldstein et al., 2008) or large-scale datasets with automated classifiers (Wang et al., 2020). While practical, some automated classifiers appear to have lower precision in instances of temporal alignment (Ramírez, Hippe, & Kuhl, 2021). In this study, we utilized an open-source classifier with higher precision when compared to the automated classifiers that are commonly used (Lavechin et al., 2021). We will also use permutation analyses to ascertain if measured contingency differs from chance; a large portion of literature does not include these analyses creating an onus for forays that do.

In the current study we tested infant–caregiver dyads at 5-months (n – 155 dyads; Infant Age Range – 4 to 6 months) and 10-months (n – 91 dyads; Infant Age Range – 10 to 12 months), during multiple types of table top interaction: free play with toys (joint play), singing with hand puppets (puppet karaoke), free play with a text-based interruptions (interrupted play), and visual obstructions blocking the partner's toys (solo play) allowing us to assess the sensitivity of interpersonal vocal contingency to the presence of stressors (interruption), reduced scaffolding (solo play) and infant-directed singing (puppet karaoke).

The percentage of vocalisations that occurred within 2 seconds of the end of another vocalisation was computed for the following temporal sequences: child-caregiver, caregiver-child. To the best of our knowledge, there have been no studies that assessed interpersonal contingency using both permutations analyses and different type of table-top interactions, or their longitudinal changes. To evaluate if there is a difference between caregiver contingency to child behaviour and child contingency to caregiver behaviour: a 2 (temporal sequences: child-caregiver & caregiver-child) X 2 (longitudinal timepoints) X 4 (type of tabletop interaction) [2 X 2 X 4] 3-way mixed ANOVA was conducted.

Results showed that temporal sequence and interaction-type each had a significant effect on contingency percentage. However, not all obtained contingency percentages differed from chance, requiring for us to compute separate analyses in instances that differed from chance. Only during puppet karaoke at 5 months and 10 months, and interrupted play at 10 months, both child-caregiver and caregiver-child interpersonal contingencies were higher than chance.

Pairwise analyses of puppet karaoke showed that caregiver-child contingency was higher than that of the opposite sequence at both time points ($t_{(113)}$ – 10.45, $p < .001$; $t_{(77)}$ – 13.43, $p < .001$). During interrupted play at 10 months, there was no significant difference ($p = .122$) showing that the presence of stressors modulates dyadic contingency. The absence of control analyses would have resulted in acceptance of ANOVA results that included some spurious contingency percentages.

Abstract 3, Title: Child-Caregiver Interpersonal Vocal Contingency at Home: A Longitudinal Study with High Precision Voice Classification

Social Contingency, the manifestation of behaviour that is temporally contingent and contiguous to the behaviour of an interacting partner, plays an influential role in parent-child interactions. Parental contingency to infant behaviour influences affective, cognitive, and language development and predicts parent-child attachment (Blehar, Lieberman, & Ainsworth, 1977; Stern, 1985; Dunham & Dunham, 1990;

Goldstein & Schwade, 2008) Most of the work in this area involves either shorter duration recordings with manually coded vocalisations (Goldstein et al., 2008), or longer recordings with automatic classifications (e.g., Wang et al., 2020) lacking the precision of hand-coding (Ramírez, Hippe, & Kuhl, 2021). Nevertheless, long recordings are fundamental to capture interactional patterns in real-world contexts creating a need for higher precision classifiers. The current work will investigate if there is a significant difference in child contingency to caregiver when compared to the caregiver's contingency to child and explore if this relationship changes over time. Recordings were made at two timepoints 5 months (*n* – 50 Dyads; Infant Age Range – 4 to 6 months) and 10 months (*n* – 22 Dyads; Infant Age Range – 10 to 12 months). The recordings were made using a custom-made wearables device that also tracked GPS co-ordinates and dyadic proximity. To ensure that there is reduced noise and comparability in the context between the dyads, we only assessed the hours where all the recorded vocalisations was indoors, inside their home (5-mo time point: *M* – 5.40 hours; *SD* – 2.68; 10-mo time point: *M* – 4.68 hours; *SD* – 2.58). Vocalisations were classified using an open-source classifier showing high precision (compared to classifiers commonly used e.g. LENA) (Lavechin et al., 2021). We employed a custom threshold that provided a precision (true positive rate) upwards of 80%. The percentage of classified vocalisations that occurred within 2 seconds of the end of another vocalisation was assessed for the following temporal sequences: child-caregiver, child-child, caregiver-child, caregiver-caregiver. The measured contingency for all four sequences was found to be different to chance. However, in opposition to our expectations, the contingency percentage of 3 temporal orders (child-caregiver, caregiver-child, caregiver-caregiver) were lower than chance, not higher. A 2 (IV 1, temporal sequences: child-caregiver & caregiver-child) X 2 (IV 2, longitudinal timepoints) [2X2] two-way mixed ANOVA was computed. The results showed that neither sequence-order (p = .256) nor age timepoint (p = .179) had a significant effect on contingency percentage, and there was no significant interaction (p = .269). This was in opposition to our expectations and the vast majority of the which suggest that caregivers are more contingent to infants when compared to infants' contingency to their caregivers (e.g. Athari, Dey, & Rvachew, 2021). Results suggest that real world caregiver-child interactions may not contain interpersonal contingency patterns observed in controlled, lab contexts, suggesting that extrapolations from free-play lab data to real world settings may not be appropriate for interpersonal contingency. Exploratory analyses will explore interpersonal contingency and its relationship to dyadic proximity.

S.56: Effects of diverse audio-visual experiences on early cognitive development

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Details

Abstract 1: Associative representation of face race and speech categories in preverbal infants

Abstract 1, Text:

Sensory inputs from faces and speech play a pivotal role in shaping perceptual development during infancy (Maurer & Werker, 2014). Infants are frequently exposed to these stimuli concurrently, such as during interactions with caregivers. However, the concurrent processing of face and speech information in infants has not been extensively explored. The present study aims to address this gap by examining the integrative representation of face and language in preverbal infants. Specifically, we investigated how infants associate face-race categories (Asian and White) with languages (English, Korean, Mandarin, Russian, and Spanish) by examining their visual preferences for actresses of different races when they spoke these languages.

We recruited 40 White (4.17-11.80 months, 23 females) English-learning infants in a multi-cultural multilingual city in Canada. In each 15-seconds trial, they saw a pair of videos depicting an Asian and a White females. They showed identical facial movement narrating a story in either infants' native (English), non-native European (Spanish or Russian), or non-native Asian (Mandarin or Korean) languages. Each infant saw 2 trials from each language-group with the face location counterbalanced.

Using an eye-tracker, we recorded infants' looking time and calculated proportional looking towards the White face as a dependent variable. If infants associate English with White faces, they should exhibit a visual preference for the White face significantly above the chance level (50%).

With one-sample t-tests, we found a significant preference for the native English condition (56%, $p=.003$), but not for the non-native European (52%) or Asian languages (50%, $ps>.05$, Fig.1). The differences among the three conditions were confirmed by a repeated-measure ANOVA ($p<.001$) and post-hoc Tukey's tests revealing that the English language condition elicited significantly higher preference than that in the Asian languages ($p<.001$) and European languages ($p=.001$). The latter two did not differ significantly.

To explore the time-course of differences in infants' preference within a trial, we analyzed infants' looking preferences in three 5-second intervals with a repeated-measures ANOVA. We found that infants showed different looking behavior over the course of trials depending on language-group ($p=.044$). While infants showed similar visual preference in the initial phase, in the second interval they exhibited significantly lower preference for White faces in Asian languages than for the English and non-native European languages ($p=.004$). In the last interval, infants showed significantly higher White face preference for in the English (61%) than non-native European languages conditions (51%, $p<.001$), which in turn was significantly higher than that in the Asian languages condition (46%, $p=.013$).

The findings collectively indicate that infants do indeed form associations between face-race categories and language types. There was a pronounced tendency for infants to associate English with White faces. However, this association was notably diminished when European languages were spoken. Intriguingly, as the speech unfolded, infants seemed to associate categorically distinct Asian languages with Asian faces. These observations suggest that associative linkages between face-race and language categories emerge during early infancy. The development of such associative representations may have a critical impact on shaping initial perceptual and social developmental processes.

Abstract 2: Infant Adaptations to Diverse Language Environments

Infants adapt to the external world by sampling (exploring) it. The more variable the environment, the more sampling (exploration) is required. Infants who regularly hear two or more languages are likely to

be exposed to more varied language input than infants who regularly hear one language. These 'bilingual' infants may also receive less input from each language. Given these exogeneous sampling constraints, how do bilingual infants keep pace with their monolingual peers? We proposed that they do so by placing more weight on gathering information (exploring) and rapidly orienting towards speakers (because visual input facilitates language learning) (D'Souza et al., 2020). In support of this proposal, we had found that infants raised in bilingual homes switch attention between visual stimuli faster and more frequently than infants raised in monolingual homes (Fig.1; D'Souza et al., 2020). But this may have been due to some effect of trial and/or non-language (e.g., cultural) difference. To rule this out and obtain a more in depth understanding of infant adaptations to bilingual environments, we have now analysed within-trial moment-by-moment eye-tracking data and investigated whether attention switching is associated with a continuous measure of language experience. We hypothesised that more attention switching between visual stimuli will be associated with more diverse language experience.

One hundred and fifty-one 7-9-month-olds were administered two eye-tracking tasks: the gap-overlap task (Johnson et al., 1991) and the change detection task (D'Souza et al., 2020). In the gap-overlap task, infants were presented with a central stimulus followed by a peripheral target. At the onset of the peripheral target, the central stimulus either disappeared (the baseline condition) or remained onscreen (the overlap condition) such that infants first had to disengage their attention from the central stimulus in order to shift it towards the target. By subtracting saccadic reaction times (SRTs) in the baseline condition from SRTs in the overlap condition, we can measure the infants' ability to visually disengage from a stimulus in order to shift attention to a new stimulus. In the change detection task, two visual stimuli were presented, with one stimulus gradually changing across trials. The number of times the infant switched visual attention between stimuli was measured.

We found that infants whose language environment was dominated by English were indeed slower at disengaging (p = .006) and switched attention less often (p = .042). Crucially, these infants fixated more on novel over familiar stimuli (as expected, based on the infant literature), whereas infants from more diverse language environments continuously switched attention between visual stimuli, irrespective of whether the stimulus was familiar or novel (p < .001; Fig.2). In other words, they placed more weight on gathering information (exploring more widely) than on prior expectations.

Since the study was carried out in a laboratory setting, we are also investigating how infants adapt to (explore) their natural environment. Pilot data from this newer, more naturalistic and interactionist study will also be presented, alongside a computational model that explains and predicts the empirical data.

Abstract 3: Impact of language familiarity on infants' recognition of faces and objects

Abstract 3, Text:

During their first year, infants adapt to the faces and language(s) that are familiar to them, providing them with efficient systems to process communicative signals from their social groups. While these two phenomena have been studied separately, little is known about the interaction between the development of these two systems. Here we report a series of experiments in our lab exploring the role of language familiarity (native vs. non-native) on infants' recognition memory for faces and objects.

The first series of experiments explored the impact of language familiarity on infant own-race face recognition. Using a Visual Paired Comparison (VPC) task, we first familiarized 9- (N=36) and 12-month-old (N=36) Caucasian French-learning infants with a picture of a Caucasian face. The face was presented with the auditory soundtrack of a French-German bilingual speaker reciting a nursey rhyme either in French (native language) for half participants, or in German (non- native language), for the other half. In the test phase, the still picture of the speaker's face was presented side by side with a picture of a novel face. We used greater looking time to the novel face relative to the familiarized face at test to index face recognition. Results showed that for both age groups, own-race face recognition was preserved when accompanied with native language, but importantly, hampered when associated with a non-native language.

To further explore whether this hampering effect was restricted to own-race faces or extended to other-race faces, we then explored the impact of language familiarity of the Other-Race Effect (ORE). The ORE describes the fact that while both 3- and 6-month-olds are able to recognize own- as well as other-race faces, 9-month-olds are, as adults, only able to recognize faces of their own race. To test this hypothesis, we ran another series of experiments using the VPC task investigating the impact of language familiarity on the ORE in 9- (N=40) and 12-month-old (N=40) Caucasian French-learning infants. Surprisingly, results showed that both groups were able to overcome their ORE, but only in the non-native language condition.

Last, in a third series of experiments we then explored whether the effect of language familiarity is restricted to the processing other communicative signals (i.e., faces) or has a larger effect on recognition memory. To do so, we tested using the same design whether language familiarity also impacts 9- to 12-month-old French learning infants (N=49) recognition memory for abstract visual patterns. Similar to own-race faces, visual patterns recognition was hampered in the non-native language condition, but preserved in the native one.

Taken together these studies show first that language familiarity impacts differentially own- and other-race faces infant recognition memory. In other words, they demonstrate the existence of a strong interaction between the development of face and language systems in infancy. Second, they also show that language familiarity impacts on a larger scale how infant process their immediate visual environment. It paves the way to a novel thread of research studying the impact of ambient sound environment (language, music) on infant learning and memory.

Abstract 4: **Effects of Diversifying Experiences on Infants' Attentional Preferences**

Recent research has suggested that diversifying experiences may modulate infants' preferences in fundamental ways. In particular, bilingual exposure appears to tune infants' visual preferences more towards novelty (D'Souza et al., 2021; Kalashnikova et al., 2021; Singh et al., 2023). This has been associated with increased attentional switching between competing visual stimuli in bilingual infants (D'Souza et al., 2021). In another domain, increased inter-racial contact has been shown to orient infants more towards novel races (Singh et al., 2022; Setoh et al., 2023). In this study, we compared how different kinds of environmental diversity – language diversity and interracial diversity – influence infants' visual-exploratory behaviors.

Two-hundred-and-four Singaporean infants were tested between 9 and 11 months of age. All infants were Chinese race. Data on other-race contact and additional language exposure were queried.

Socioeconomic status was collected via maternal and paternal education. Being raised in a multilingual, multiracial environment, infants received varying exposure to a range of second languages (English; Mandarin; Malay; Tamil) and similarly, had varying amounts of contact with other races.

Infants were tested on a visual recognition task where they were presented with two side-by-side displays over 10 trials. As each trial progressed, one display stayed the same and the other changed subtly. Infants' relative attention to the changing trial (i.e., novelty preference) over the experiment was logged.

First, we examined the role of sociodemographic factors (i.e., age; gender; maternal and paternal education) on novelty preferences in the visual memory task. Second, we investigated whether diversity in language exposure and in race exposure predicted a novelty orientation in the visual memory task. Lastly, we investigated the role of attentional switching in the visual memory task as a predictor of a novelty orientation.

A linear regression demonstrated that novelty preference in the visual memory task was not predicted by sociodemographic factors (age; gender; maternal and paternal education (all p-values>.2). We then examined the role of diversifying experiences, additional language exposure and inter-racial contact, on novelty preferences. Using infants' novelty preferences as a dependent variable, we analyzed the effects of additional language exposure and other-race contact on novelty preferences via hierarchical linear regression. The model was significant, R^2 = .05, $F(2, 173) = 4.09$, p = .018. Of the two predictor variables, only the extent of additional language exposure positively predicted novelty preferences p = .015; the extent of other-race contact did not. Lastly, via linear regression, we found that bilingual exposure did not predict attentional switching (p = .90), nor did attentional switching predict novelty orientation in the visual memory task switching (p = .31). This suggests that contributions of other-language exposure to novelty preferences were not due to increased attentional switching. Results indicate that language diversity modulates fundamental aspects of attentional preferences, leading to a greater orientation towards changing (novel information). In contrast, racial diversity did not have similar effects. Results will be discussed in the context of specific components of bilingual experience that may lead to an adaptive orientation towards novelty.

Abstract 5: Are attentional, linguistic, and memory flexibility associated among monolingual and bilingual infants?

Perceptual, linguistic, and memory systems undergo less specialization in early development, with modifications in one system likely impacting the trajectories of others and their underlying neural architecture (Karmiloff-Smith, 2011). Bilingual environments introduce variations in emotion and face processing (Ayneto & Sebastián-Gallés, 2017) and memory flexibility (Brito & Barr, 2014), yet the interplay between attention to social cues, memory flexibility, and emotion processing remains unexplored.

In the present study, we tested 78 8- to 10-month-old infants using two eye-tracking tasks that examine eye gaze tracking, and emotion processing and a memory flexibility imitation task to assess whether flexible memory processing is associated with attentional patterns. Infants' eye gaze data was collected automatically using a Tobii 23'' eye tracker monitor placed around 65cm away from the child (Tobii Tx300). Infants sat on their parent's lap in a quiet testing room facing a monitor. A brief child-friendly 5-

point calibration procedure occurred at the beginning of each task to ensure accurate eye-tracking. Data collection is ongoing.

Eye gaze following task. The original stimuli from Experiment 1 of Senju and Csibra (2008) were used. Stimuli consisted of videos of a female actor sitting at a table, directing her gaze to one of two colorful toys. Two measures, the time spent looking at the object that the actor looked at was the congruent object, and shifts between object was calculated.

Emotion Task: We replicate the Ayneto and Sebastián-Gallés (2017) task that measures looking at three 30-second-long video recordings of three male infants displaying neutral, positive (laughing), and negative expressions (crying). We measure the difference between looking at the face vs. the eyes during each expression.

Memory flexibility: Deferred imitation generalization task. Three target actions are demonstrated on one puppet, and after a 15-minute delay, they are tested in a different room with a different puppet.

Hypotheses. We predicted that there would be considerable variation in gaze following, that bilingual infants and monolinguals would differ in their allocation of attention on the emotion-processing task, and that bilingual infants would show better memory flexibility than monolingual infants.

Preliminary Results. We found a trending relationship between children's memory flexibility scores and their length of fixation to the congruent items ($r(34) = .31$, $p = 0.064$). When examining eye gaze and emotion processing relationship, children who focused their attention more on the congruent item versus the incongruent one were more likely to focus on the eye regions for both non-neutral trial types in the emotions processing task (laughing: $r(32) = .35$, $p = 0.04$ and crying: $r(29) = .32$, $p = 0.08$). Against our hypotheses, there were no significant differences between monolinguals and bilinguals across all tasks (either as a binary classification or a continuous variable).

Conclusion. Our study sheds light on the intricate interplay among attention, memory, and bilingual experiences in early infancy. While the findings do not support our initial hypotheses regarding the role of multilingual exposure, the intriguing associations discovered between attentional patterns, emotional processing, and memory flexibility underscore the complexity of early cognitive development. These insights pave the way for further exploration into the nuanced relationships between language exposure, attentional mechanisms, and socio-cognitive development in infancy.

Abstract 6: Infants demonstrated the McGurk effect with own-race but not other-race faces

Abstract 6, Text:

Speech perception is multisensory, dominated by auditory information but subjected to visual cues as well (e.g., mouth movement). The McGurk effect indexes such audiovisual integration nature. For example, when we see mouth articulating the syllable /ka/ paired with the sound /pa/, we would hear an illusory /ta/.

Established in early infancy, the McGurk effect is regarded as a fundamental perceptual capacity independent of linguistic experiences (Rosenblum et al., 1997). However, a recent study proposed that infants exhibited this effect selectively to own-race but not other-race faces (Ujiie et al., 2021),

suggesting an experiential perspective of this perceptual capacity. Nevertheless, this finding was based on a measure of memory, which could be independently affected by experience of face race. Thus, it is unclear if the perception process of the audiovisual integration is indeed biased by infants' visual experience. To this end, the current study aims to address the discrepancy with a memory-independent perception task.

Sixty-one (6-12 months, 29 females) Asian Mandarin learning infants participated. In each trial, they heard the same syllable repeating twenty times at the pace of 1s/iteration. These sounds were dubbed with videos of a female face articulating a particular syllable. These videos were interleaved by a still face image to formulate a "moving-still-moving-still" pattern. Should infants perceive the McGurk effect, their auditory perception should be modified during the moving section, but not the still section, leading to the percept of two alternating sounds. Otherwise, they should hear the same sound repeating (Figure 1).

We designed the alternating trials using the McGurk stimuli (audio /pa/-visual /ka/ or audio /ba/-visual /ga/) and the non-alternating trials used non-McGurk stimuli (audio /ka/-visual /pa/ or audio /ga/-visual /ba/). Infants would be more interested in the former trials than the latter, if they showed the McGurk effect. To test this hypothesis, we used infants' looking time as the dependent variable. To examine the influence of visual experience, we used videos of Asian (own-race, n=33) and White females (other-race, n=28).

We divided participants into younger (6-9 months) and older (9-12 months) groups. The older group looked longer in the alternating trials (paired t-test, p=.040) in the own-race condition, but not in the other-race condition (p=.210), suggesting that infants perceive the McGurk effect only in with own-race faces. The younger group showed longer looking time in the non-alternating trials (p=.020) in the own-race condition, but not in the other-race condition (p=.80, Figure 2).

In summary, the current finding suggested that infants exhibited more reliable McGurk effect with own-race faces than other-race faces, replicating previous findings. Considering that the current evidence is established on the contrast between the likely McGurk vs unlikely McGurk stimuli, the race effect may imply an early formed cross-modal representation between face category and speech sounds: some audiovisual syllable combinations may be more legit when paired with own-race faces than other-race faces. Moreover, the difference between the two age groups further suggests the developmental change in this mental representation.

Abstract 7: Early Prediction Abilities and Executive Function Development in Monolingual and Bilingual Infants

Infants as young as 6-months are able to form expectations about events in their environment and then update these expectations in light of new information - a cognitive process known as prediction. The way in which this skill is shaped by language experience (e.g., exposure to two languages) is not yet well understood. Previous research has argued that bilingual infants may be more successful at updating their predictions compared to monolingual infants due to advanced executive functions (EFs; e.g., Kovács & Mehler, 2009), although the link between early EFs and infants' predictive abilities has not been directly assessed. More recent accounts suggest that monolingual and bilingual infants may differ in the way in which they initially encode information in their environment, which in turn, might influence their prediction updating abilities. That is, the need to monitor and sample the high variability of a bilingual

environment would be reflected in weaker initial associations formed by bilingual infants during prediction tasks.

To test these hypotheses, we analysed anticipatory eye movement data from 9-month-old monolingual (*n* = 20) and bilingual (*n* = 22) infants in a prediction task (Figure 1). In each trial, infants were presented with a fixation target paired with a non-linguistic auditory cue (i.e., a whistle sound). The cue was followed by a 1-second anticipatory period. Finally, a visual target appeared on one side of the screen consistently for the first 9 trials (pre-switch phase), and on the opposite side for the next 9 trials (post-switch phase). Infants' gaze proportions to the expected target location were measured during the anticipatory period, and analysed in successive blocks of 3 trials. Additionally, caregivers completed an EF questionnaire focusing on their infant's behaviour during a two-week period (i.e., Early Executive Functions Questionnaire; Hendry & Holmboe, 2021). Results revealed comparable anticipatory looking behaviour across monolingual and bilingual infants. A phase by block interaction indicated that the pattern of infants' gaze proportions across blocks differed depending on the phase of the experiment. In the pre-switch phase, infants' gaze proportions were equivalent across blocks. In the post-switch phase, significantly lower gaze proportions were observed in the first block compared to the second and final blocks of trials. This indicates that while infants were able to learn the location of the target reward in the pre-switch phase, they persisted in fixating their attention on this location for the first three trials post-switch before updating their predictions to the new target location. Furthermore, no significant difference was found between groups with respect to their EF questionnaire scores. Similarly, no significant relation was found between infants' individual performance and their EF scores, suggesting that while it has been proposed that EFs are engaged in this task, individual differences in EF do not appear to drive the observed effects. We will discuss our findings in light of more recently proposed theories on the effects of bilingualism on attention, while also highlighting questions raised by this study with respect to task design and the monolingual and bilingual samples tested.

Abstract 8: Older infants' social learning behavior under uncertainty is modulated by the interaction of face and speech processing

Abstract 8, Text:

The majority of infants grow up with people who belong to their own race and speak their native language. These early experiences shape infants' social learning behavior: In social situations of uncertainty, 7-month-olds are more likely to follow the gaze of own-race individuals (Xiao et al., 2018) and 5- and 12-month-olds look longer at objects presented by a native speaker (Marno et al., 2016). However, it remains unclear how infants' social learning behavior is affected when both information are provided simultaneously. Hence, the current study investigated whether and how infants' social learning in terms of gaze following is influenced by face race and language origin of an interaction partner in an uncertain situation.

Our sample consisted of 91 Caucasian infants from German speaking families. They were divided into 2 age groups: Younger infants were 5- to 8-month-old (n = 46) and the older infants 11- to 20-month-old (n = 45). Due to the Covid-19 pandemic, infants participated online. We used a modified version of the paradigm by Xiao and colleagues (2018) by varying face race and language of a female actor. A between-subjects design with four conditions (European / German, European / French, Asian / German, Asian / French) was utilized. During the 16 learning trials, the female actor addressed the Baby ("Hey baby, look at this") and turned her head in the direction of one of the four screen corners. An animal appeared at

the gazed corner on 50% of the trials. In the following four test trials, the animal did not appear (see Figure 1). We recorded infants looking behavior via webcam and coded looking times to the gazed corners during the test phase offline. We conducted an ANOVA with mean looking times to the gazed corners as dependent variable and Face race (European vs. Asian), Language (German vs. French) and Age (5-8- vs. 11-20-month-olds) as between-subjects variables.

Our analysis revealed a significant main effect for Face race $F(1,83) = 14.14$, $p \leq .001$, $\eta p2 = 0.15$. Post-hoc analysis show that infants followed the gaze of the European actor ($M = 0.48$, $SD = 0.24$ s) significantly ($p < .001$) longer than the gaze of the Asian actor ($M = 0.23$, $SD = 0.28$ s). Additionally, we found a significant main effect for Age, $F(1,83) = 22.83$, $p \leq .001$, $\eta p2 = 0.22$, and a significant Face race x Language x Age interaction, $F(3,83) = 3.98$, $p = .049$, $\eta p2 = 0.05$. Older infants ($M = 0.51$, $SD = 0.49$ s) followed the gaze significantly ($p < .001$) longer compared to younger infants ($M = 0.20$, $SD = 0.24$ s). As can be seen in Figure 2, the one year olds followed the own-race, native-speaking actor clearly the longest.

Taken together, our findings show that infants from one year on are clearly influenced by the adults' ethnicity and language in social situations of uncertainty. Based on our results, future studies might advance this area of research by investigating mono- and bilingual infants using an eye tracker

S.57 Converging Evidence towards a Non-Unified Attention Framework

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Summary

How do infants select the information to attend to? This symposium adopts an integrative approach, acknowledging multiple theoretical perspectives to better understand attention development and inform future research. We present novel evidence from screen-based and naturalistic studies, with different methodologies, such as EEG, fNIRS, behavioural assessments, and eye-tracking to study how both low- and high-level factors influence infant attention. Paper 1 discusses the moment-by-moment influences of exogenous and endogenous factors on infant attention during naturalistic play and how these change over time. Paper 2, the active role of the learner in seeking information, examining how infants weigh information to guide attention allocation and maximise learning. Paper 3, the role of memory-guided attention, exploring how infants integrate the information they learn to modulate attention. Our discussant will integrate the presented findings within the memory-attention framework.

Details

Infants face an impressive challenge of making sense of the myriad of information in their environment; every day they receive more information than their brains can process. How do they select the appropriate information to attend to? What controls attention allocation? A large body of literature has contributed to our understanding of the multiple factors influencing attention during development. Yet, the debate persists on whether attention is primarily driven by physically salient stimuli in an automatic manner or by stimuli that match the observer's goals. Instead of juxtaposing one theory against another, the current symposium adopts an integrative approach, acknowledging multiple theoretical perspectives

to reach a deeper understanding of attention development and inform future research. We present novel evidence from both screen-based and naturalistic studies, encompassing a range of different methodologies, such as EEG, fNIRS, behavioural assessments, and eye-tracking, to study how both low- and high-level factors influence infant attention. Paper 1 discusses the moment-by-moment influences of exogenous and endogenous factors on infant attention during naturalistic play and how these change over time. Paper 2 addresses the active role of the learner in seeking information from the environment, examining how infants weigh information to guide attention allocation and maximise learning. Paper 3 focuses on the often-overlooked role of memory in guiding attention, exploring how infants quickly integrate the information they learn to modulate attention. Our discussant will integrate the presented findings within the memory-attention framework.

Abstract 1 Title: Exploring developmental changes in how endogenous and exogenous factors influence infant attention in real-world settings

Introduction: The ability to allocate and maintain visual attention enables us to adaptively regulate perception and action, guiding strategic behaviour within complex, dynamic environments. This ability develops rapidly over the early years of life and underpins all subsequent cognitive development and learning. Studying the mechanisms through which attention control develops during early life is key for identifying and intervening in atypical development. However, we understand little about how different factors influence the capacity for attention control within real-world settings.

Hypotheses: Our goals are to investigate the interplay of moment-by-moment changes in both endogenous and exogenous factors to understand how infants spontaneously allocate attention, and to consider how these inter-relationships change across development. More specifically, we wondered whether the regulation of naturalistic infant attention shifts from being predominantly influenced by exogenous to endogenous factors with developmental time. In Analysis 1, we examined the associations between attention patterns, autonomic arousal, and neural activity in 5- and 10-month-olds during free solo play with toys. In Analysis 2, we will explore the influences of certain exogenous factors originating from the social partner on the ability to capture and maintain infant attention at 5 and 15 months.

Study population: Data were collected as part of the Oscillatory Neural and Autonomic Correlates of Social Attunedness project, an ERC-funded study following infants and their mothers during the first 30 months of life. The final sample for Analysis 1 includes data from 31 infants at 5 months and 29 at 10 months playing *alone* with toys. Analysis 2 will include behavioural data from 24 infants at 5 months, and 24 infants at 15 months, and their mothers while playing *together* with toys.

Methods: For Analysis 1, we looked at *endogenous* influences on infant attention and recorded autonomic arousal, brain activity and spontaneous attention patterns in infants during free solo play with toys. We used time series analyses to examine whether changes in autonomic arousal and brain activity anticipate attention changes or follow on from them. For Analysis 2, we focused on *exogenous* influences and observed free-flowing tabletop toy play between infants and their mothers, and micro-coded their gaze behaviours at 50Hz. Following this, we will process lower-order salience factors coming from the mother, such as variations in maternal pitch and changes in specific facial parameters (e.g. mouth openings, eyebrow raises) to explore their association with infant attention.

Results: Early in infancy, slow-varying fluctuations in autonomic arousal forward-predicted attentional behaviours (Fig 1A). The same pattern was present at 10 months, but not significant (Fig 1B). Later in infancy, fluctuations in fronto-central theta power associated with changes in infants' attentiveness and predicted the length of infants' attention durations. Crucially, changes in cortical power followed, rather than preceded, infants' attention shifts, suggesting that processes after an attention shift determine how long that episode will last. For Analysis 2, we expect that as infants' visual attention becomes increasingly less controlled by exogenous influences, changes in lower order salience will be more predictable of infant attention at 5 months compared to 15 months.

Figure 1. Relationship between infant autonomic arousal and attention. Cross correlation between infant autonomic arousal and attention at 5 months (**A**) and at 10 months (**B**). Infant autonomic arousal forward-predicting infant attention on the negative lags. Infant attention forward-predicting infant autonomic arousal on the positive lags. Black lines show the observed cross-correlation values, shaded grey areas indicate the SEM. Shaded yellow areas show confidence intervals from the permuted data. Significant time lags identified by the cluster-based permutation analyses are shown by a thick orange line.

Abstract 2 Title: Early roots of information-seeking: Infants predict and generalize the value of information

Introduction: As infants learn to interact with their environment, they develop expectations about where and how to find valuable information. This allows them to focus their attentional resources on stimuli that are likely to provide useful information while ignoring irrelevant ones, resulting in more efficient learning. This process of information-seeking is the foundation for a lifetime of learning, but its origins are not yet well understood. Previous research has demonstrated that even infants as young as 8 months of age guide their attention based on the informativity of stimuli (Poli et al., 2020) and can identify which social partner is more reliable in delivering information (Tummeltshammer et al., 2014). Nevertheless, the cognitive mechanisms behind these abilities have yet to be described. We propose that that statistical learning (Kirkham et al., 2002; Krogh et al., 2012) and generalization processes (Aslin, 2017; Kemp et al., 2007; Lake et al., 2015; Yuan et al., 2020) jointly support infants' ability to learn where information can be found.

Methods: Our research, conducted through two studies employing eye-tracking and fNIRS, investigates how infants assess the informativity of upcoming stimuli. We presented 8-month-old infants with multiple static shapes, that had either smooth or pointy borders and a red or blue color. One feature (e.g., border type) predicted whether the shapes would be informative of the target location (by moving in its direction) or not (by moving randomly). Across multiple presentations, infants could thus learn what stimuli were predictive of later events.

Results: The first study revealed a decrease in pupil size across informative trials indicating that infants learned that specific cues predicted whether they would later receive information about the location of a reward (Figure 2). This supports the growing body of evidence indicating that infants are proactive in shaping their learning environment by searching for and focusing on information-rich stimuli (Poli et al., 2023, 2020). Remarkably, infants also demonstrated the ability to generalize this learning to new stimuli with the same features, showcasing their adeptness in applying learned concepts to novel situations. The second study focuses on exploring the neural underpinnings of infants' prediction of informative cues, particularly examining the Prefrontal Cortex (PFC). Recent theories posit that the PFC is

instrumental in processing task-related abstract information, integrating stimulus and contextual data with temporal aspects of tasks (Alexander & Brown, 2015; Badre & Nee, 2018; Koechlin & Summerfield, 2007; Paulus et al., 2021). The ongoing data collection for this study aims to further elucidate the role of the PFC in infants' learning processes.
In conclusion, our studies aim to shed new light on the cognitive processes that underlie infants' remarkable learning skills. Specifically, they identify the ability to form expectations about the informativity of new stimuli as a fundamental aspect of their learning. Hence, it contributes to a mechanistic understanding of how infants develop models of the social and physical world around them at such a breathtaking rate, models that they can rely on to guide their attention.

Figure 2. Pupil dilation during informative and uninformative events. A. Bayesian additive models estimated pupil change during the predictive time window, with informative trials in red and uninformative trials in blue. The shaded areas represent the standard error (darker) and 89% credible interval (lighter) of the estimate. The x-axis displays time in milliseconds and the y-axis shows the estimated pupil change from baseline. **B**. Overall, the estimated pupil change was lower for informative trials compared to uninformative trials. **C**. The difference between the conditions developed over trials, as infants learned which stimuli were informative. Across trials, the pupil constricted more in informative trials while it remained unchanged in uninformative trials.

Abstract 3 Past Experience Drive Infants' Attention in the Present

Introduction: Traditionally, research has focussed on the idea that visual attention is governed by two primary factors: stimulus salience and task goals[1]. Despite the theoretical importance of this dichotomy, the emphasis on this has, to some extent, eclipsed the role of memory in guiding attention allocation. In our everyday life memory constantly informs what to attend to, helping us navigate our environment and guiding our behaviour[2]. For instance, we immediately stop for the sound of an ambulance but not for the routine traffic noise during our morning walk. Since the early days of attention research in the 1960s, it has become evident that memory plays a crucial role in directing attention allocation[3]. A classic example is the cocktail-party effect[4], where experience-relevant information captures our attention amidst the background noise. Despite early evidence, the extent to which this mechanism operates has been often overshadowed, particularly in developmental populations. Infants learn at an outstanding pace during the first years of life. Do infants leverage past experiences to guide their attention? If so, how swiftly does this process unfold? In the present study we investigated the role of prior experience on infants' attention allocation both at a behavioural and a neural level.

Methods: A 2x24-channel NIRS system covering the frontal and the temporo-parietal regions and a TX300 eye-tracker were employed to record participants' brain activity and eye-behaviour respectively. In the first phase of the study, we exposed thirty, 8-month-old infants to two shapes, one shape paired with a social reward (informative distractor) and one shaped without reward (uninformative distractor). In line with previous evidence[5], participants' looking preference after this cue-reward association showed a trend of longer looking times towards the informative distractor (M= 0.52ms, SD=0.05ms) than the uninformative one (M= 0.29ms, SD=0.04ms). In the second phase of the study, we investigated the impact of memory on attention allocation. Short video-clips were played in the middle of the screen, while the two shapes appeared as distractors in the periphery. Importantly, the two shapes appeared without rewards. If memory-guided attention is at play, infants' attention would be captured more by the informative (the shape previously associated with the social reward) than the uninformative

distractor. Behavioural and neural indexes are measured as markers of memory guidance over attention.

Results: Data from 29 participants showed faster saccadic latencies (informative M =805.79ms, SE =77.64ms; uninformative M =934.26ms, SE=120.99ms) and longer looking time (informative M =453.58ms, SE =40.2ms; uninformative M =284.25ms, SE = 25.64ms) to the informative than uninformative distractors. Similarly, our preliminary fNIRS data highlighted a sensitivity to informative over uninformative distractors in the frontal regions, which have been previously associated with memory and attention processes[6]. In contrast, the temporo-parietal regions indicated sensitivity to the presence of the distractors regardless of its valence. Our findings provide new insights into the interplay between memory and attention in driving infants' attention. Results will be discussed within the memory-guided attention framework, emphasising how, from a very young age, past experiences help us navigate amongst the salient features that compete for attention.

S.58 Replicating Belief Tracking, Rule Learning, and Social Evaluation in Infancy: Updates from ManyBabies 2, 3, & 4

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Summary

ManyBabies (MB) is a global consortium of developmental psychology labs working collaboratively on large-scale replications and best practices in developmental psychology research. Almost 100 developmental labs located in over 30 countries around the world collected data from over 2000 infants and toddlers as part of the ManyBabies 2 (Theory of Mind), ManyBabies 3 (Rule Learning), and ManyBabies 4 (Social Evaluation) projects. Project leaders from these projects are pleased to come together to share the results of these massive collaborative studies for the first time.

Details

Abstract 1, ManyBabies 2: Theory of Mind in Infancy

Nearly two decades ago, studies with spontaneous response tasks revolutionized Theory of Mind research. They suggested that even infants are capable of tracking other agents' false beliefs (Scott & Baillargeon, 2017) and thus challenged existing theoretical assumptions. However, the new paradigms have come under scrutiny in recent years: partial or failed replications cast doubt on their robustness (Barone et al., 2019). To bring clarity to the current puzzling empirical situation, ManyBabies 2 has assembled a group including the original study authors and those involved in prior replication attempts to integrate diverse theoretical perspectives and conduct large-scale conceptual replications of the most influential paradigms (Buttelmann et al., 2009; Onishi & Baillargeon, 2005; Southgate et al., 2007).

In the initial phase, we target the robustness of anticipatory looking paradigms by investigating whether toddlers visually anticipate how others will act based on their goals and epistemic status. In our first registered report, we probe whether toddlers (and adults as reference) take into account another

agent's epistemic status in their spontaneous goal-based action anticipation (Schuwerk, Kampis et al., IPA): do they track whether someone did/did not see a crucial event, and therefore does/doesn't know something?

In the study, participants watched animations showing hide and seek scenarios in which one agent (chaser) wants to catch another agent (chasee). In four familiarization trials, we introduced the agents, their game, and situational constraints (to get to the chasee, the chaser has to walk through a tunnel and take one of two exits). In the critical first test trial, we manipulated whether the chaser knows or doesn't know where the other agent is hiding (knowledge vs. ignorance condition, Figure 1). A total of 35 labs from 15 countries and 4 continents collected data from 582 18-27-month-old toddlers (M_{age}= 22.5 months, SD_{age}= 2.8 months) and 646 adults.

A first round of preliminary analyses with a subsample (N = 254 toddlers, 273 adults) showed that in the familiarization trials toddlers and adults reliably anticipated the chaser's reappearance at the tunnel exit where the chasee can be found as indicated by a mean proportion looking score of 0.59 (95% CI=[0.56, 0.62]) for toddlers (significantly differed from chance, 0.5, p<.001) and 0.71 (95% CI=[0.68, 0.73]) for adults (significantly differed from chance, 0.5, p<.001). In the critical first test trial, for adults, we found the predicted stronger looking bias in anticipation of the agent's knowledge-based as compared to ignorance-based action ($M_{Knowledge}$= 0.61, $SD_{Knowledge}$= 0.36; $M_{Ignorance}$= 0.39, $SD_{Ignorance}$= 0.34; condition effect in a Bayesian mixed-effects regression: b = 0.20, 95% HDI=[0.12,0.28]). Surprisingly, for toddlers, this effect was flipped ($M_{Knowledge}$= 0.52, $SD_{Knowledge}$= 0.36; $M_{Ignorance}$= 0.72, $SD_{Ignorance}$= 0.33; b = -0.15, 95% HDI=[-0.25,-0.07]). This indicates that toddlers'–like adults'– visual action prediction is influenced by the epistemic state of the agent, but follow-up analyses are necessary to explain the unexpected pattern of results. At the conference, we will present the full set of confirmatory and exploratory follow-up analyses from this unprecedentedly rich eye-tracking data set.

Abstract 2, ManyBabies 3: Rule Learning in Infancy

The ability to learn and apply rules lies at the heart of cognition. Rules are essential in many cognitive abilities, in areas as diverse as problem-solving (Anderson, 1996), social cognition (Kunkel, 1997), cognitive development (Siegler, 1983), and developing causal reasoning (Kuhn, 2012). Rule learning and representations are considered particularly relevant in the area of language acquisition. In a seminal study, Marcus, Vijayan, Rao, and Vishton (1999) reported that seven-month-old infants learned abstract rules over syllable sequences and were able to generalize those rules to novel syllable sequences. Dozens of studies have since replicated that finding and extended it using different rules, modalities, stimuli, participants (human adults and non-human animals), and experimental procedures. Yet questions remain about the generalizability of Marcus et al.'s (1999) core findings, and the sources of variation across these findings. In a meta-analysis of 91 samples, Rabagliati et al. (2019) found a small but significant rule-learning effect in infants. However, they also found large variability in reported effect sizes.

In the current study, we address this issue by testing infants of a wide age range (5;0-12;0 months) in a multi-laboratory conceptual replication Marcus et al. (1999). The study aims to include a large and diverse sample of infants - and to involve a large and diverse cross-section of scientists. Rule-learning studies so far have been overwhelmingly conducted in English-speaking countries and labs and the original stimuli contained synthetic English-specific sounds. Hence, new stimuli were designed to be phonologically balanced and broadly interpretable for infants with a wide variety of linguistic

backgrounds by selecting consonants and vowels that would be perceived as distinct across a large number of languages (Dryer et al., 2013). The syllables were recorded by a male speaker, they were normalized, and a syllable identification task was used to verify the interpretability of the newly developed stimuli.

In this study, first, infants are either familiarized with the ABA or the ABB pattern by listening to a speech stream composed of 16 unique syllable sentences for approximately two minutes. Afterward, during the test phase, infants listen to six sentences each, either consistent or inconsistent with the pattern they were exposed to in the familiarization phase. Each sentence is repeatedly presented for a maximum of six times or until the infant looks away for more than two seconds (Figure 1). Rule learning is evidenced by a novelty preference for inconsistent patterns at test, based on looking times towards the visual stimulus.

Data are collected in 25+ labs, 10+ countries, involving infants with a large variety of primary languages and multilingual backgrounds. Data of 300+ participants has already been collected and the final expected sample size is 600+ by March 31, 2024. Beyond testing the rule learning effect in a large and diverse sample, this study tests whether the effect is modulated by i) age, ii) experimental paradigm (head-turn preference, eye-tracking, central fixation), and iii) linguistic background. At the conference, we will present the full dataset and analyses of this large dataset in rule-learning.

Abstract 3, ManyBabies 4: Social Evaluation in Infancy

Since Hamlin and colleagues' (2007) seminal study on infants' preference for prosocial over antisocial others, an ever-growing body of work has investigated the emergence and development of infants' sociomoral reasoning. Such works have revealed that infants' social preference for prosocial over antisocial others extends across not only diverse methodologies, but also various sociomoral domains (for review, see Woo et al., 2022). While meta-analyses suggest that these effects are broadly robust (Margoni & Surian, 2018), there have been many individual replication attempts that have failed for reasons that remain unclear.

ManyBabies 4 assembled a large group to conduct a large-scale multi-lab investigation on infants' social evaluations, using the original Hamlin et al. (2007) findings as a case study. The project had three overarching goals. First, it aimed to shed light on the true effect size for infants' helper preference, and the methodological and/or contextual factors that affect replication attempts. Second, it sought to develop best practices for multi-lab collaborative projects, including training for interactive experimental protocols and policies for video sharing across countries with diverse ethics requirements. Finally, it created a large and diverse dataset to serve as the foundation for additional analyses and experiments.

Across 35 labs from 17 countries, ManyBabies 4 collected data from 687 (48% female) 5.5-10.5-month-old infants (M = 254 days, SD = 44.94 days, Range = 154 - 329 days). Infants watched pre-recorded videos of the Hill paradigm used in Hamlin et al. (2007). In the social condition, a protagonist puppet (red circle with eyes) first attempted to climb up a hill. After several failed attempts, it is either helped by a puppet who pushes it up the hill (helper), or hindered by one who pushes it down (hinderer). In the nonsocial condition, the protagonist is replaced by an inanimate, eyeless red circle, and infants watched a puppet either push the red circle up the hill (push-up puppet), or push it down (push-down puppet). After habituating to these videos, infants were presented with physical versions of the two characters, and prompted to choose one.

Preliminary analyses showed no condition differences in infants' tendency to select the helper/push-up character: In the social condition, 49.7% selected the helper (175/352), whereas in the nonsocial condition, 52.4% selected the push-up character (174/332). Additional analyses showed moderate evidence in favour of the interaction effect between conditions and whether infants reached the habituation criterion prior to the manual choice (BF = 5.20). Non-habituated infants showed higher tendency to choose the helper/push-up character in the social condition (52.9%) than in the nonsocial condition (40.6%), while habituated infants showed higher tendency to choose the helper/push-up character in the nonsocial condition (57.6%) than in the social condition (48.2%).

We will present the full set of confirmatory and exploratory analyses from this rich dataset, and discuss implications of these findings with respect to both prior work and findings that have been published since the inception of this project, as well as implications for future projects.

S.59 The Multiple Facets of Infants' Social Learning

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Summary

This symposium aims to enhance our understanding of the multifaceted nature of infants' social learning. *Study 1* reveals systematic variation across 18-month-old US and Yucatec Mayan infants' attention and learning in infant-directed and observed social settings. *Study 2* shows the learning potential of observation in preverbal infants and reveals an increasing sensitivity from visual to physical joint attention from 9-18 months. *Study 3* shows that during everyday activities, 12-25-month-olds are highly attentive to relevant objects and actions and parent and infant attention is coordinated in real time. *Study 4* reveals heightened emotional expressiveness in caregivers when interacting with 6-14-month-old infants versus adults. By studying infants across cultures, ages, and settings, with diverse methods, and by considering interaction dynamics and adult emotions, the symposium offers innovative insights into the diverse factors organizing infants' social interaction and learning.

Details

Abstract 1, Learning Words from Teaching and Observation in Yucatec Maya and US infants:

Directed teaching interactions are thought to be foundational for early social learning (e.g., Csibra & Gergely, 2011), in part because of how these interactions help direct attentional focus. However, explicit teaching occurs with low frequency in many parts of the world (e.g., Rogoff et al., 1993), leaving open the question of how infants who receive limited directed teaching in their everyday lives respond to directed and observational interactions. The goal of this study is to explore infants' attentional strategies and learning via teaching and observation in communities where directed interaction is more and less common. Thirty-two infants (13 female, Mean age = 18.8 months, range 15.9-23.2) from a large city in the United States and Thirty-two Yucatec Mayan infants from Mexico (14 female, Mean age = 18.8 months, range 15.8-22.7) participated in a within-subjects design where they were taught two novel

words, one via directed interaction and one via observation, and were tested for label retention immediately following training as well as after a one-week delay. Infants' visual attention during training and the relationship between attentional allocation and learning were assessed.

US infants demonstrated immediate word learning in both the Overheard and Directed condition; they selected the target object more often in test as compared to control (mutual exclusivity) trials ($F=[2, 25] = 5.03$, $p< 0.05$) and one-tailed t-tests showed they selected the target object at above-chance rates in both the Directed ($t[26]= 2.79$, $p<0.05$) and Observed ($t[30]= 2.56$, $p<0.05$) conditions, see Figure 1A. However, after delay, infants only showed above chance responses for the label heard in directed interaction ($t[24]= 2.44$, $p< 0.05$). US infants deployed similar overall attention to the Directed and Observed conditions, but were more likely to shift attention between the labeler and the addressee in the Observed condition ($t[29] = 2.13$, $p< 0.05$). Time spent doing so was related to learning via overhearing ($r= 0.49$, $p< 0.05$).

On immediate testing, Mayan infants showed no evidence of learning, they did not select the object reliability more on test than control trials ($F(2,24) = 0.359$, p=ns). However, during follow-up testing Maya infants chose the target object more on target trials than on control trials ($F[2,24] = 5.70$, $p<0.05$) and selected the previously labeled object significantly more than chance in the Directed condition ($t[31] = 2.62$, $p<0.05$) and marginally above chance in the Observed condition ($t[31] = 1.98$, $p= 0.056$). Unlike US infants, Mayan infants attended to the Directed training longer than the Observed training ($F[2,24] = 10.67$, $p< 0.01$) and they looked longer to the labeler in the Directed condition ($F[2,24] = 6.74$, $p< 0.05$). However, for Maya infants, visual attention did not predict learning.

The results suggest that directedness may have value based on the sociocultural weight that infants assign to these kinds of interactions. In addition, while attentional allocation likely shapes the ability that infants have to learn via observation, the attentional strategies that infants utilize are shaped by culture and do not have a universal link to later word learning.

Abstract 2, Infants' Increasing Sensitivity to Physical Cues of Joint Attention During Observational Learning:

Social interactions involving joint attention to an object facilitate object learning from infancy onwards. Most previous studies on social learning in infancy have focused on learning situations involving high levels of infant-directed communication and eye contact. This study aimed to broaden this perspective by investigating infants' object encoding in the context of observed triadic interactions, and by comparing their ability to recognize social connectedness based on visual and physical social cues. Specifically, we investigated whether and when infants can infer that two people are jointly attending to an object based on their mutual interpersonal touch, without eye contact.

The final sample consisted of 64 typically developing German infants from two age groups: N = 32 9-month-olds (n = 15 female, age range: 9.0 to 10.0 months) and N = 32 18-month-olds (n = 15 female, age range: 18.02 to 19.0 months). Participants were presented with 16 trials of a screen-based object encoding task. Each trial consisted of a familiarization phase and a preferential-looking phase. In the familiarization phase, infants saw one of four kinds of videos showing two women looking an abstract toy-like object. Based on a 2x2 within-subjects design (see Figure 1B), the scenes varied with regard to (a) the eye contact between the women (mutual eye contact or looking away from one another) and (b) whether or not they engaged in interpersonal touch (mutual touch in close physical proximity or no

touch in a distal setting). In the preferential looking phase, the previously familiarized object reappeared next to a novel object. Using eye-tracking, we measured infants' proportional looking time at the novel object. We hypothesized that if infants had encoded the object during the familiarization phase, they should show a looking time preference for the novel object in the preferential-looking phase.

In 9-month-olds, we found a significant main effect of eye contact, with higher novelty preference scores in the eye contact conditions compared to the no eye contact conditions ($\chi2(1) = 10.82$, $p = .001$, estimate = .29, SE = .09). In 18-month-olds, we found a significant interaction between eye contact and touch ($\chi2(1) = 10.34$, $p = .001$, estimate = −.54, SE = .17) with higher novelty preferences in all three conditions involving interpersonal connectedness (established through visual, physical, or both modalities in combination) compared to the parallel attention condition (no eye contact, no touch), see Figure 1C.

Our findings suggest that German infants at 9 months primarily rely on eye contact to recognize joint attention between two people and that, as they develop, they become increasingly attuned to physical cues of shared attention. By 18 months, mutual touch in physical proximity can replace eye contact as a means of conveying joint attention. We will discuss the implications of our findings in the context of within- and across-cultural variation in how human infants connect with and learn from others.

Abstract 3, Learning from observation: Infant attention to parents' actions during everyday activity:

Introduction. Infant social learning unfolds through dynamic exchanges with caregivers. In daily activities such as meal preparation, caregivers produce a continuous, complex stream of actions, and infants observe, interact with, and learn from those actions. The goal of the present study is to examine how infants perceive others' actions and how caregivers' attention impacts infants' attention during everyday activities.

Method. In a home-like lab environment, 12- to 25-month-old infants (N = 40) sat in a highchair approximately the height of the kitchen counter as parents prepared peanut butter and jelly sandwiches. Both parents and infants were outfitted with head-mounted eye-trackers, providing a continuous record of their gaze patterns. As shown in Figure 1D, there were both task-relevant objects (e.g. knife, plate, peanut-butter jar) and irrelevant objects (e.g. a fruit bowl and a flower vase) on the kitchen counter. We annotated both infants' and parents' attention to those objects (Figure 1E) and coded the 13 actions parents used to make the sandwiches. We focused here on the 7 most common actions (e.g., moving bread to the plate, spreading peanut butter on the bread, cutting the bread into two pieces). On average, caregivers generated 27.30 actions per minute in this action-packed everyday task.

Results. The results reported here are based on 26 sandwich-making trials from 8 dyads with complete data annotation. There are three major findings from the current data analysis. First, we found that during the entire PB&J-making session, infants primarily attended to task-relevant objects (e.g., knife, bread; M = 55.6%; green bars in Figure 1F) and rarely looked at task-irrelevant objects (e.g., colorful fruit bowl or flower vase; M = 2.4%) even though task-irrelevant objects were more visually salient than task-relevant ones. This observation suggests that infant attention is top-down and goal-driven.

Second, we examined infant real-time attention to individual actions (Figure 1E). Overall, infants paid close attention to ongoing actions, spending M = 28.4% of each action looking at the one or two objects

used during the action out of the 21 visible objects on the counter. And when infants were not looking at the objects directly involved in the ongoing action, they looked at other task-relevant objects (M = 37.2%). Infants' looking to the objects used in each action did not differ based on the specific action type, $F(7,64) = 1.39$, $p = .19$ (Figure 1G).

Finally, we tested the coordination between infant and parent attention. Parents looked at the objects used for each action at a similar level to that of infants (M = 38.5%). During the individual actions when parents spent a longer time attending to the objects they were using, infants also looked longer at those objects, $r(822) = .21$, $p < .001$.

Conclusion. The results here contribute to our understanding of how infants navigate the continuous and complicated flow of information within everyday activities. Next, we will examine infants' anticipatory gaze, which can provide insight into their learning of the action sequence.

Abstract 4, Adults Tailor Their Emotional Expressions to Infants Through "Emotionese":

Adults adjust their behaviors when interacting with infants, using simplified, slower, and more dynamic speech (infant-directed speech or "parentese") and more expansive and repetitive movements (infant-directed actions or "motionese"). These modifications enhance infants' attention and comprehension of language and actions (e.g., ManyBabies Consortium, 2020; Brand & Shallcross, 2008). Yet, it remains unknown if and how adults adapt their emotional expressions to infants, an aspect we call infant-directed emotion expressions or "emotionese."

This study explores how adults express emotion to infants. In Experiment 1, 25 parents with infants aged 6-14 months viewed positive and negative pictures (Figure 1H) and described their feelings to either their infants (infant-directed) or an adult experimenter (adult-directed). We coded their facial expressions every half-second on a -5 (negative) to 5 (positive) scale (ICC=.83). We found an interaction between condition (infant vs. adult-directed) and picture valence (positive vs. negative; $F(1, 72)=8.24$, $p=.005$). In the adult-directed condition, participants showed positive expressions regardless of discussing positive (M=.86) or negative (M=.85) pictures ($t(24)=0.19$, $p=.85$, $d=.04$), suggesting these expressions may serve social functions (e.g., to appear polite); they used language instead to convey their feelings (e.g., "I feel scared…"). When communicating with infants, participants relied more on facial expressions. They were less positive (though not negative) when discussing negative pictures (M=.37) compared to positive ones (M=.89; $t(24)=-3.36$, $p=.002$, $d=.67$; Figure 1I), indicating that infant-directed expressions provide richer emotional information compared to adult-directed ones.

Experiment 2 addressed the potential influence of intimacy levels between the participant and their partner in Experiment 1: In the adult-directed condition, the partner was an unfamiliar experimenter; in the infant-directed condition, it was the participants' infants. To address this, another group of parents (N=37) with infants aged 6-14 months discussed their feelings about the same pictures as in Experiment 1, either with a close adult (e.g., spouse) or their infants. We coded participants' facial expressions the same way as in Experiment 1 (ICC=.83). An interaction was found between condition and picture valence ($F(1, 96)=19.42$, $p<.001$). When talking to a close adult, participants showed varying facial valence when discussing positive vs. negative pictures: their expressions were less positive for negative pictures (M=.81) than for positive ones (M=1.20; $t(31)=-2.84$, $p=.008$, $d=.50$). Yet, this difference was more pronounced in the infant-directed condition (negative: M=-.15; positive: M=.81; $t(35)=-6.87$, $p<.001$,

d=1.14; Figure 1J), indicating that although emotional expressions directed to close adults provide some emotional information, those directed to infants remain more informative.

In sum, adults' facial expressions convey richer emotional information when interacting with infants compared to adults. Like infant-directed speech and actions aid language and action understanding, infant-directed emotional expressions may support the acquisition of emotion knowledge. The findings shed light on "emotionese," expanding our understanding of the richness and benefits of parent-infant interactions.

S.60 The Heartbeat of Connection: Physiological Insights into Infant-Caregiver Co-Regulation

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Summary

This symposium comprises four research groups whose work converges through the utilization of physiological measures to advance understanding of how co-regulation dynamics contribute to infants' emotion regulation. The researchers employ experimental paradigms and analytical techniques to delineate between infant-led, parent-led, and bidirectional influences. Speaker 1 presents evidence that mothers' playsongs, but not lullabies, increases infants' physiological arousal. Speaker 2 discusses how infants' own characteristics, including vagal reactivity, moderate the influence of maternal regulation. Speaker 3 compares how parents' intrusive and withdrawn behaviors affect infants' emotion regulation during mother-infant, father-infant, and triadic interactions. Speaker 4 shows how mothers' differential vocal and semantic reactions to infants' distress moments can impact the duration of negative affect, utilizing longitudinal data in naturalistic environments.

Details

Abstract 1: Infant Physiological Responses to Live Maternal Singing

Infant-directed (ID) singing has traditionally been divided into playsongs and lullabies, which have distinct acoustic features and are argued to arouse and soothe, respectively (e.g., Cirelli et al., 2020). However, recent physiological evidence suggests that maternal singing of both lullabies and playsongs is associated with decreased or stable infant arousal (Cirelli et al., 2020; Cirelli & Trehub, 2020; Trehub et al., 2015). We propose that the physiological effects of playsongs and lullabies might actually be better captured using further physiological measures beyond infant measures of skin conductance, an indicator of sympathetic nervous system response (Carlson, 2013). Infants regulate themselves and are regulated on a cardiovascular level, highlighting the interplay of both the sympathetic and the parasympathetic nervous systems and, thus, the adaptability of the autonomic nervous system to changing environmental requirements (Appelhans & Luecken, 2006). Accordingly, the aim of this study was to examine infants' cardiovascular physiological regulation to live and dynamic maternal singing.

Mothers sang a playsong and a lullaby to their 7-month-old infants (N = 30) in a semi-naturalistic laboratory setting while we recorded infant electrocardiography. We measured infant arousal via heart rate variability (HRV). HRV is a marker of adaptability of the autonomic nervous system (Appelhans & Luecken, 2006), with low HRV values indicating high arousal (Pumprla et al., 2002). The singing conditions were preceded by a 60s silent baseline, and the order was counterbalanced across participants. Playsongs and lullabies were acoustically distinct, with playsongs being sung faster ($z = -4.12$, $p < .001$), louder ($z = -4.72$, $p < .001$), and in a higher pitch ($z = -3.22$, $p = .001$) than lullabies. Preliminary results from a mixed ANOVA on infant HRV levels show a significant effect for the playsong ($p = .002$), indicating a significant decrease in HRV from the baseline to the playsong condition (see Fig. 1). There was no significant difference between HRV during the baseline and the lullaby condition ($p = .796$), nor did we find significant differences between the two baseline conditions ($p = .054$) and the two singing conditions ($p = .069$).

Our results show that playsongs are related to an increase in physiological arousal, while lullabies were not related to physiological changes in infants. These findings suggest that the regulatory effects of playsongs and lullabies are distinct. In further analyses, we will compute other arousal parameters (e.g., IBI, RSA) to probe further measures of infants' physiological reactions to live ID singing.

Abstract 2: Infants' Vagal Reactivity and Mother-Infant Co-regulation

Early on, infants rely on caregivers for support and co-regulation through face-to-face interactions, physical closeness, and shared vocal exchanges. Despite extensive evidence of behavioral co-regulation, little is understood about the contributions of physiological co-regulation to infants' development. There is substantial variation in infants' capacity for regulation due to differences in the development of the vagus nerve from late gestation to six months postpartum. Respiratory sinus arrhythmia (RSA), an indicator of physiological regulation (Porges, 2007), reflects increasing vagal tone associated with internal homeostasis during rest (RSA increases) and vagal suppression (RSA decreases) during external challenges. Although mothers with higher vagal tone have been shown to possess enhanced emotion regulation capacities (e.g, Balzarotti et al., 2017), their ability to co-regulate with their infants may vary as a function of individual differences in infants' vagal reactivity.

In our study with 4- to 6-month-old infants and their mothers (N= 132), we measured infants' and mothers' RSA and infants' negative affect during the Face-to-Face Still-Face paradigm to investigate whether individual differences in infants' vagal reactivity contribute to variations in co-regulation with caregivers. Co-regulation is assessed by examining the strength of bidirectional relationships between mothers' and infants' responses after a stressor (Reunion). Due to their adaptability, suppressor infants typically engage in more positive and synchronized interactions with caregivers during face-to-face play (e.g., Moore & Calkins, 2004). We hypothesized that suppressors may benefit from their mothers' regulatory support during Play and Reunion, where mothers' RSA, reflective of sensitive caregiving, is associated with changes in infants' negative affect. Conversely, non-suppressor infants, lacking the ability to regulate their physiology, may be more distressed, prompting their mothers to decrease RSA as they initiate a regulatory response (Oppenheimer et al., 2013).

Non-suppressors consistently showed higher negative affect across the FFSF phases. Suppressors exhibited expected RSA patterns: a decrease from Social Play to Still-Face, followed by an increase in Reunion. Non-suppressor infants increased RSA from Social Play to Still-Face, with a trend to decrease in Reunion. Mothers of non-suppressor infants also displayed significant vagal reactivity, increasing RSA

during Still-Face, then decreasing in Reunion (see Figure 1). Cross-lagged panel models were used to examine concurrent and lagged relationships between infants and mothers across phases. For suppressors, mothers' concurrent RSA and mothers' RSA during Social Play predicted infants' negative affect during Reunion, ß = 0.02, *p* = 0.03, and ß = -0.05, p < 0.001, respectively. Mothers' and infants' RSA during Reunion were bidirectionally linked, ß = -0.12, *p* = 0.02. However, for non-suppressors, no concurrent associations were observed between mothers' RSA and infants' RSA and negative affect in Reunion. Instead, higher levels of infants' negative affect in Social Play predicted lower mothers' RSA during Reunion, ß = -2.04, *p* = 0.02. These results suggest that among suppressors, mothers' RSA is bidirectionally linked to infants' negative affect and vagal activity following a stressor. In contrast, mothers of non-suppressors adjust their RSA in response to infants' distress, and this regulation is predicted by the initial degree of infants' negative affect, rather than concurrent affect.

Abstract 3: Dynamic associations between mothers' and fathers' parenting behaviors and infant physiological emotion regulation

Emotion regulation (ER) is a key developmental process, that is primarily shaped through parent-infant interactions, with parents and infants dynamically co-regulating infant emotions during interactions in the first months of life. Successful co-regulation hinges on parents responding appropriately to the infant's emotional signals; past research in mother-infant dyads has shown that unadjusted parental responses may cause stress in the child, which is measurable at the physiological level, e.g. heart rate. Although research on parent-child interactions has advanced our understanding of infant ER, gaps still exist. For example, most studies focused on mother-infant dyads, neglecting fathers' contributions. Moreover, limited research explored infant ER during triadic mother-father-infant interactions and the dynamics between infants' physiological responses and parents' behaviors in real-time, leaving key aspects of ER unexplored. In this study, we examined relationships between infant heart rate and parents' behaviors during mother-infant, father-infant and mother-father-infant interactions, hypothesizing positive associations between unadjusted parent's behaviors and infant heart rate.

The sample consisted in 80 families with a 3-month-old infant. We asked parents to interact with their infant during three successive 2-min sequences of mother-infant, father-infant and mother-father-infant free play, during which we recorded infant heart rate with a Biopac MP160 system. Each interaction sequence was divided into 5s intervals, resulting in 24 intervals for each sequence and 72 in total for each family (n = 5760 intervals in total for the whole sample). The occurrence and strength of intrusive and withdrawn parental behaviors were coded from 0 = "absent" to 4 = "strong unadjusted behavior", and infant heart rate averaged in each interval, resulting in two parallel time series. We conducted a dynamic network analysis using multilevel vector autoregression to investigate contemporaneous and cross-lagged effects (lag-1) within and between the two time series. As intrusive behaviors were particularly prevalent, we also explored their specific relationship with infant heart rate overall and separately during mother-infant, father-infant and mother-father-infant interactions.

Taking both intrusive and withdrawn behaviors together (see table 1), results showed positive and significant contemporaneous associations between parents' behaviors and infant heart rate: stronger parents' unadjusted behaviors were significantly associated with increased infant heart rate. Results of cross-lagged (lag-1) estimates showed significant bidirectional effects: stronger intrusive/withdrawn behaviors in one interval predicted increase in infant heart rate in the next, while the reverse was also true. Between-subject effects showed that, on average, stronger intrusive/withdrawn behaviors were associated with infant's increased heart rate. Results of separate analyses for intrusive behaviors

showed similar patterns of results with significant contemporaneous associations and bi-directional cross-lagged effects between the variables. Finally, separate analyses of the links between intrusive behaviors and infant heart rate in the different contexts of interaction showed that, in mother-infant and mother-father-infant interactions, only contemporaneous, but not lagged, associations between the variables were significant, while in father-infant interactions, only cross-lagged associations of infant heart rate influencing fathers' stronger intrusions were significant. Discussion of the results will particularly focus on the potential causal influences between parenting behaviors and infant ER.

Abstract 4: Matching or Modeling: Maternal Affective Responses to Infant Distress

Using naturalistic dyadic data collected from wearable devices recording daylong sessions, we seek to understand how mothers' affective vocal responses to infant distress differentially impacts infants' speed of recovery. Is it better to match your infants' mood by being sad when they are sad? Or does maintaining a positive upbeat mood aid quicker calming?

Naturalistic mother-infant interaction research indicates that mothers engage in 'dynamic affective state matching' with their infants, upregulating their own arousal when infant arousal is at a high point, with this greater responsivity linked to faster infant calming (Wass et al. 2019). But research is scant on the behavioural analogues of this upregulation: is the valence of parental vocalisations key to soothing infants? As well as how they say it, is what they say important? Do parents match their child's emotions in circumstances of high child arousal, or rather model a calm state their child can match?

Research indicating that increased maternal distress upon observing child distress is correlated with child negativity (Frankel et al. 2015), that parental accommodation of child anxious behaviours is related to increased child anxiety (Lebowitz et al. 2013), and that parental arousal is contagious (Waters et al. 2014; Smith et al. 2022) may indicate that parents should model behaviours that do not mirror their child's distressed behaviour, rather than matching these aspects of their child's behaviours.

The current study uses data recorded using wearable devices worn by mothers, and their infants (at 5, 10, and 15mo; N=89) throughout daylong recordings at home. Each device records audio, ECG, actigraphy, proximity between devices, and GPS information. Episodes of infant distress are indexed when a z-scored autonomic arousal composite (heart rate (BPM) and heart rate variability (RMSSD)) crosses a session-relative percentile threshold. Rate of recovery from these peaks in infant arousal is assessed using the area under the curve of the subsequent arousal measurement in a 3-min window following the peak. Maternal autonomic arousal response is assessed by measuring change in z-scored arousal from 2 mins before the peak to 30 seconds after; affective behavioural response is assessed using vocal valence and arousal coding of audio in this window as well as automatic sentiment analysis of automatically transcribed audio. Preliminary regression analyses of maternal autonomic arousal response replicate previous findings (Wass et al. 2019) that increased maternal upregulation of arousal is significantly associated with quicker infant calming from distress (β = -2.12, SE = 0.857, p = 0.013). Full results from vocal and semantic analysis of maternal affective responses on infant recovery from distress will be presented at the time of conference, with it hypothesised that more positively valenced affective maternal responses to distress will lead to more effective infant calming.

S. 61 Drivers of visual attention in infancy: Insights from studies of individual differences, naturalistic stimuli, and large-scale datasets

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Summary

Infant looking behavior, a common measure in studies of cognitive development, is driven by many factors (e.g. stimulus salience, learning goals).Studying drivers of looking is a valuable empirical enterprise and critical for proper interpretation of these behaviors. .Talk 1 presents proposed work to test for effects of stimulus complexity and rate of information change on infants' looking towards photographs and movies. Talk 2 finds that looking behavior is reliable within individual infants, even across different knowledge domains. Talk 3 presents meta-analytic evidence that longer looking to unexpected events and to visually novel events are systematic but independent processes. Talk 4 presents analyses from a large-scale eye-tracking database on early word comprehension, showing that mapping images to words is robust and sensitive to the salience of the stimuli. In sum, these talks showcase the value of using a variety of methods to study the complexity of infant looking behavior.

Details

Abstract 1: Infants' preferences for stimuli of various visual complexities: Evidence from four online studies

Infants must choose what to learn from the complex world around them. Kidd and colleagues (2012, 2014) showed that infants seem to prefer those stimulus sequences that are neither too boring or too complex - "the Goldilocks effect". It is hypothesized that this type of attentional preference facilitates learning. It is unclear, however, whether infants try to optimize other sources of complexity. In the world, there are various dimensions of complexity (visual complexity, semantic complexity, etc.) that might affect infants' attention and could interact with each other. Similarly, it may be the case that some dimensions of complexity exist but do not drive infants' attention. Understanding what drives infants' attention provides us with better insight into which aspects are relevant for shaping learning.

Here, we set out to test whether infants show a preference for stimuli at various types of visual complexity. We conducted four experiments with looking time as the main measure. In Experiments 1 and 2, we manipulated the visual complexity of the stimuli (videos and pictures respectively). In Experiments 3 and 4, we manipulated the rate of visual information change. We hypothesized that if infants' learning is affected by these types of complexities, we should observe preferential looking-behavior to those stimuli that are at a "Goldilocks level" of complexity.

A total of 188 2-14 month-old infants (Exp 1: N=25, Exp 2: N=50, Exp 3: N=54, Exp 4: N = 59) were included in the final analyses. We conducted all four experiments asynchronously online via a browser-based platform. In Experiment 1 and 2, infants were shown videos and pictures of three types of visual complexity: simple drawn, complex drawn, live-action/photo (see Figure 1). In Experiment 3 and 4, infants were presented with a series of pictures that morphed from one into the other at various speeds (Exp 3: 1000 ms, 3000 ms, 8000 ms; Exp 4: 400 ms, 530 ms, 1000 ms, plus a static presentation of the stimulus between morphs: Exp 3: 1000 ms; Exp 4: 70 ms, 130 ms, 270 ms). With these manipulations, we varied

the rate of visual information change. All experiments used a within-subject design with one stimulus block (Exp 1: 180 seconds per block, Exp 2-4: 90 seconds per block) per condition, yielding three looking time measures per infant. Completion of all conditions was an inclusion criterion. Looking behavior was recorded via the webcam and the video data were manually annotated.

Our preliminary analyses suggest that infants' looking behavior does not vary across different levels of visual complexity (Exp 1-2) or rate of information change (Exp 3-4). These dimensions of complexity seem not to affect learning to the same extent as sequence complexity did in previous studies. In our presentation, we will discuss the full set of results and the implications of these findings both for the scientific theories of infant learning as well as for stimulus creation in experimental studies with infants.

Abstract 2: Looking time stability across social and physical violations of expectation

In violation-of-expectation (VOE) experiments, researchers hypothesize that infants will look longer at events that are unexpected. Previous work found a significant correlation between infants' looking to multiple unexpected physical events (i.e., objects passing through a wall or floating in mid-air), but not expected physical events (i.e., objects stopping in front of a wall or sitting on a table; Perez & Feigenson, 2022). This suggests that within the physical domain there are consistent individual differences in the detection of unexpected events, motivation to seek an explanation for them, or both. Here, we asked whether those individual differences extend across domains: do infants who invest more time looking to unexpected social events also look longer to unexpected physical events (N=71)? We additionally explore different approaches to analyzing looking time data that may better capture individual differences in violation detection.

In Exp.1, we investigated 10- to 11-month-old infants' expectations of empathy between friends. Infants saw a pair of friendly social agents, then one agent observed their partner achieve a goal. In test trials, the observing agent reacted positively (expected) or negatively (unexpected) to this success. Infants looked longer when the observer reacted negatively, $F(1,67)=9.656$, $p=.003$, indicating that infants expect empathic responses for a friend's success. In Exp.2, we replicated the finding that 15- to 16-month-old infants expect objects to obey gravity. Infants saw two objects, one that behaved surprisingly (i.e., floating in mid-air) and one that behaved expectedly (i.e., continued to be supported by a block). Infants looked longer at the event that featured the unexpected outcome, $F(1,69)=8.630$, $p=.004$. At the group level, infants looked significantly longer at both unexpected outcomes. However, whether or not we observed a cross-domain correlation in unexpected looking depended on how we analyzed the data. When we used the maximum amount of looking allowed in our methods (60 seconds), there was not a statistically significant correlation between individual infants' looking at the social and object violations, $r(69)=0.15$, $p=.201$. When we only analyze the first 10 seconds of infants' looking, following Perez and Feigenson (2022), there was a positive correlation between infants' looking at the social and object violations, $r(69)=.29$, $p=.016$ (Fig.1).

The discrepancy between analytical approaches suggests that there may be an optimal time frame where looking duration contains valuable information about individual differences in cognitive development. The positive correlation between experiments at the adjusted threshold suggests that violation detection is stable across domains. While this work does not address why some infants might look much longer than others, the lack of correlation in the longer looking threshold does invite the possibility that the kind of information infants are looking for may be different across domains. Future

work should investigate how looking time may relate to and predict behavior within and across domains at the individual and group level.

Abstract 3: Infant looking is guided independently by stimulus- and expectation-driven novelty: Meta-analytic evidence

Infants look longer at events that are unexpected (the 'violation of expectation' or VOE response). But for as long as VOE studies have existed, researchers have debated their reliability and interpretation. One concern is that the VOE effect is too unreliable and noisy to be informative about infant minds. A second is that longer looking to unexpected events is reducible to a more basic process of stimulus-driven novelty (perceptual novelty, or PN).

Here, we studied both looking behaviors using a pre-registered meta-analysis of data from 33 papers that tested infants' understanding of agents and objects (76 conditions, N=1899 3-12mo infants). In each condition, we used data from the last habituation, first expected, and first unexpected trials to study the VOE effect (unexpected - expected), and the PN effect (expected - last habituation; in all conditions, the expected event was visually novel). Since we measured VOE and PN in the same datasets, we could compare the size and moderators of each effect controlling for all other experimental variables.

First, showing infants an unexpected event drove their looking behavior as reliably as showing infants a visually novel event (VOE: 0.290 standardized mean units, 95% CI [0.208, 0.372]; PN: 0.239 [0.109, 0.369]; $p < .001$; comparison between effects, $p = 0.287$). Second, these two effects varied systematically but independently; different moderators predicted the size of each effect (see Figure 1). Familiarization studies showed smaller PN effects than habituation studies ($B = -4.568$, [-5.451, -3.685], $p < 0.001$), but this factor did not predict the VOE effect ($B = -0.196$, [-1.169, 0.778], $p = 0.694$; exposure phase X trial type: Likelihood Ratio Test, $p < .001$). Infant age predicted the VOE effect ($B = -1.323$, [-0.194, -0.709], $p < 0.001$), with younger infants showing bigger VOE effects, but did not predict PN ($B = 0.450$, [-0.052, 0.951], $p = 0.079$; infant age X trial type: Likelihood Ratio Test, $p < .001$). See Figure 2.

Data from individual infants in 60 conditions (N=1482) allowed us to test the robustness of the finding linking the process of habituation to PN, but not VOE. Habituation predicted responses to visual novelty, in individual infants, across all experiments. In habituation studies, infants who habituated more steeply (i.e. underwent fewer habituation trials) recovered more attention to visually novel events (estimate = -0.061, [-0.093, -0.035], $p < .001$). In familiarization studies, infants who met a standard habituation criterion (50% decrease in looking between the first and last three trials) recovered more attention to visually novel events, relative to those who did not (estimate = 0.531, [0.387, 0.674], $p < .001$). But neither of these individual differences predicted the size of the VOE effect ($p > 0.7$; significant interactions with trial type, $p < .001$).

From these findings, we suggest that processing conceptually unexpected information, and processing visually novel information, are distinct processes in infant minds

Abstract 4: Looking while listening: infants' visual attention during lexical processing in a large-scale eye-tracking database.

The ability to allocate visual attention in response to language is key to infants' developing language skills. A commonly used method to measure word recognition is the "looking-while-listening" (LWL) paradigm. In this paradigm, researchers present infants with two images and a prompt sentence (e.g., *Look at the dog!*), tracking eye movements to measure how quickly and accurately infants fixate the target image in real time. Word recognition undergoes rapid developmental change, but measuring these changes is challenging, in part due to limitations of scale: individual experiments typically investigate looking behavior in a small infant sample for a small set of words, limiting our ability to estimate item-independent change in word recognition skill.

Peekbank (http://peekbank.stanford.edu) tackles these challenges by creating a large-scale, open database of LWL datasets aggregating data from many infants and children across a variety of items, with the goal of informing theoretical questions in lexical development. Peekbank collects eye-tracking datasets on children's word recognition, introduces a data format for standardizing eye-tracking data, and provides an interface for accessing the database (the peekbankr R package). Peekbank includes twenty-five datasets (N=1,807) spanning a wide age range (6-70 months), with additional datasets in the pipeline.

First, we find that infant word recognition accuracy (proportion target looking) is reliable, as measured by intraclass correlation coefficients (ICC), both for participants (average by-dataset ICC = 0.45, 95% CI = [0.37, 0.54]) and items (ICC = 0.65, 95% CI = [0.55, 0.75]), and that measurement reliability increases with longer analysis windows that aggregate more looking behavior (Figure 1). Second, the large set of items and participants allows us to develop robust estimates of developmental change in word recognition accuracy. We find a log-linear relationship between age and accuracy of lexical recognition: the log of looking-based accuracy increases linearly with infant log age ($b = 0.95$, $t(1673)=17.19$, $p < .001$), consistent with a classic law of skill acquisition (Anderson, 1982).

Third, we investigate item-based variation, finding that the visual salience of the target and distractor image influences looking behavior. As one proxy for visual salience, we consider animacy. Animate items (e.g., a dog image) tend to have higher salience than inanimate items (e.g., shoe). Using a linear mixed-effects modeling approach, we find that target animacy ($b = .18$, $t(75.6)=2.02$, $p =.047$) predicts higher and distractor animacy ($b=-.21$, $t(22.2)=-3.80$, $p<.001$) predicts lower target looking. Moreover, the influence of distractor animacy decreases as infants grow older ($b=.22$, $t(89.0)=2.10$, $p=.038$; Figure 2). This result highlights that the relative salience of items exerts a strong influence on infant looking behavior that may obscure infant word knowledge, particularly at younger ages.

Overall, building large-scale databases allows us to make data-driven methodological choices and improves our ability to answer theoretical questions about lexical development and infant looking behavior.

S.62 The third cord: understanding and harnessing strengths of infant-parent dyadic connection

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Summary

Triangulating findings across multiple international data sets and diverse methodologies, we provide novel insights into the nature, structure, and importance of relational processes connecting the infant-parent dyad. The third cord in the rope intertwining infant and parent- is their connection. It is this connection, which strengthens the plait. Understanding this relationship, above infant and parent alone, completes their powerful framework.

Details

Title: The nature and structure of maternal parenting practices and infant behaviors in U.S. national and international samples

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Background and Rationale: A previous test of three competing models of the nature and structure of the maternal parenting practices supported a hybrid 2 factor/6 domain model as superior to a 1-factor dimensional model and a multi-factor style model. Maternal parenting practices are structured into nurture, physical, social, didactic, material, and language domains undergirded by dyadic and extradyadic factors. Infant behaviors were organized into physical, social, exploration, non-distress vocalization, and distress communication domains. The current paper examines links connecting these maternal domains and factors with infant behavior domains using structural equation models.

Methods: Twenty maternal parenting practices and 15 behaviors of their 5½-month-old infants in a U.S. national sample (N = 360) and 9 international samples (N = 653) were microcoded from videorecords of naturalistic interactions at home and aggregated into domains. The samples were recruited from Argentina, Belgium, Brazil, France, Israel, Italy, Japan, Kenya, as well as the United States.

Results: The maternal dyadic factor is associated with infant social behaviors with mother; and the maternal extradyadic factor and encouragement of infant physical development are associated with infant exploration of their immediate physical environment and their physical development. Infant distress communication is associated with more maternal nurturing.

Discussion: Mothers' parenting practices in the middle of the first year of infant life are commonly structured and adapted to specific needs and developmental tasks of infants. Evaluations of mother-infant interactions with national and international samples permit a wide yet judicious analysis of culturally common vs. culturally specific models of mother-infant relationships.

Abstract 2: Title: On the potential risks of secure attachment in infancy: Adolescent anxiety, PTSD and depression symptoms predicted by secure attachment and high approach behaviours at 14-months towards a caregiver living with inter-parental violence

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Introduction: The attachment classification 'secure' is assigned to the infant who turns to a caregiver on reunion in the Strange Situation Procedure (SSP). This may reflect an approach strategy which is adaptive in a non-threatening environment but which may create vulnerability in the presence of threat in the family. We tested prospectively the hypothesis that secure attachment, and approach behaviours following separations in the SSP, will be associated with anxiety, PTSD and depression symptoms in adolescence among children exposed to inter-parental violence.

Methods: We followed 199 families recruited from the general population during pregnancy (members of the Wirral Child Health and Development Study; WCHADS), with attachment assessments (Strange Situation Procedure; SSP) at 14 months, maternal interviews about inter-parental violence at 2.5, 5 and 7 years, and adolescent reported depression, anxiety and PTSD symptoms at age 13 years. In addition to the standard SSP secure/insecure classification, a latent variable reflecting approach behaviours during the two reunions was generated from the SSP dimensional scores on proximity seeking, contact maintenance and avoidance of contact, and a factor score extracted. Analyses used path analysis using the gsem command in Stata.

Results: Secure attachment classification and approach behaviours were weakly positively correlated (.15, $p = .031$). There were significant interactions between attachment security and inter-parental violence for age 13 depression ($p = .039$) and age 13 PTSD symptoms ($p = .043$). For depression, this arose as from greater levels of depression among secure children subsequently exposed to inter-parental violence. Conversely, for PTSD this arose from greater levels of PTSD symptoms among insecure children exposed to inter-parental violence. The interaction term to age 13 anxiety was non-significant. The pattern of the interaction for approach behaviours was consistent across the three emotional disorder outcomes (depression, interaction term $p = .004$, anxiety interaction term $p=.020$; PTSD interaction term = $p < .001$). Higher approach behaviours during SSP reunions among children exposed to inter-parental violence were associated with depression, anxiety and PTSD. Among children who were not exposed to partner violence higher approach behaviours in the SSP were associated with lower symptoms.
Conclusion: Infant behaviours characteristic of attachment security in the Strange Situation Procedure may not equip children to deal with exposure to inter-parental violence and associated parental negativity. Whilst the pattern of results was similar across the classification and approach behaviour score in predicting depression symptoms, results differed for PTSD, with the insecure classification conferring risk for PTSD symptoms. Using the dimensional score of approach behaviours, the pattern of results was the same for all three emotional disorder outcomes. The findings highlight the potential context dependent impact of attachment security. They also raise

important questions as to what is gained and lost by focussed vs broad conceptualization and measurement of attachment relevant behaviours.

Abstract 3: To know and be known: the proportion of genetic similarity for liability for neuroticism in mother-child and mother-father dyads is associated with reported relationship

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Aim: To explore the influence of genetic similarity for neuroticism in mother's reported quality of relationship with her child and partner. Such understanding could provide insight into the role of genetic similarity in close relationships.
Method: Molecular genetic data in 4,704 mothers, partners, and children in the Avon Longitudinal Study Parents And Children (ALSPAC) study were used to derive the proportion of genetic similarity between mother and child, as well as mother and partner, for genetic variants associated with neuroticism. The associations between genetic similarity scores and mothers' reported enjoyment and conflict in the parenting relationship (child age 0-3) and her reported relationship with the partner were examined.
Results: For a one standard deviation (SD) increase in similarity in mother and child genetic variants associated with neuroticism, there was a 0.15 SD point (95% CI=0.003 to 0.500, p=0.046) increase in maternal reported enjoyment in their relationship. This association was greater where mother and child were both in the top quartile for high neuroticism (standardised beta=0.29, 95% CI=0.56 to 0.02, p=0.034). Similar patterns of results emerged for similarity for genetic variants associated with neuroticism between mothers and partners, and the quality of the mother-partner relationship reported by the mother.
Implications: These results highlight how phenotypic variation linked to genetic liability in one individual may be influenced by the genetic liability of those around them. Thus, parenting and intimate partner relationships were explained not by one or the other's genetic score, but by their combination. The associations between genetic similarity and parental enjoyment were small and explain only a small proportion of the variance. Thus, other parental and child factors, both genetic and environmental, are important in explaining variance in parenting. Nonetheless, these exploratory findings present an intriguing mechanism by which combined genetic liability might influence family relationships.

Abstract 4: Title: Early parenting interventions to prevent internalising problems in children and adolescents: a global systematic review and network meta-analysis.

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Background Child anxiety and depression (i.e., internalising problems) represent an important and increasing societal and economic burden worldwide. While most commonly used parenting programmes

have robust evidence supporting their effectiveness in reducing child behavioural problems, National Institute for Health and Care Excellence (NICE) and World Health Organization (WHO) guidelines for reducing internalising problems are lacking. No network meta-analysis has yet investigated the comparative effectiveness of early parenting interventions on child internalising difficulties, which may have very different mechanisms as compared to externalising difficulties. To address this gap, we performed a systematic review and network meta-analysis including any parenting programme regardless of their original aim, where internalising problems were measured (even if not published).We then compared the effectiveness of different types of parenting interventions based on an a novrl priori taxonomy of parenting interventions, and the impact of waitlists versus treatment as usual (TAU), in reducing child internalising problems.
Methods We conducted a systematic review and network meta-analysis of published and unpublished randomised controlled trials (RCTs) until 1 October 2022 that investigated parenting interventions with children younger than 4 years. Exclusion criteria: studies with children born preterm, with intellectual disabilities, or families receiving support for current abuse, neglect, and substance misuse. Using 59 randomised controlled trials, we explored the effects of early parenting interventions across the following relevant outcomes: child internalising and externalising problems, parental depressive symptoms and sense of self-efficacy. We assessed the certainty of evidence using the Confidence in Network Meta-Analysis framework. We used random-effects network meta-analysis to estimate standardised mean differences (SMDs) with 95% credible intervals (CrIs).
Findings Of 20 520 citations identified, 59 RCTs (18 349 participants) were eligible for the network meta-analysis. Parenting interventions focusing on the dyadic relationship (SMD: −0.26, 95% CrI: −0.43 to −0.08) and those with mixed focus (−0.09, –0.17 to −0.02) were more effective in reducing internalising problems than TAU at the first time point available. All interventions were more effective than waitlist, which increased the risk of internalising problems compared with TAU (0.36, 0.19 to 0.52). All effects attenuated at later follow-ups. Most studies were rated as with ‘high risk’ or ‘some concerns’ using the Risk of Bias Assessment Tool V.2. There was weak evidence that all parenting interventions improved self-efficacy and that home visiting interventions reduced parental depressive symptoms. There was no strong evidence of effect modification by theoretically informed components or modifiers.
Conclusions Considering all the outcomes at different time points, parenting interventions that focused on the parent–child relationship and had mixed intervention targets were most successful in reducing internalising and externalising problems in children at the first time point available but with no long-term (>3 years post-intervention) sustained effects; in addition, we found strong evidence that the waitlist comparator increased internalising problems with implications for waiting times between referral and support and that those assigned to waiting list reported worse symptoms on all outcomes.

S.63 COVID-19 Pandemic Effects: Maternal-Child Health Outcomes

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Summary

Examine COVID-19 impacts on parents and infants, leveraging longitudinal designs and pre/post comparisons. Gustafsson et al. focus on pandemic-related stress (PRS) and infant distress proneness

(N=525). Infants with greater in-utero exposure to the pandemic exhibited higher fear, as did those whose parents reported greater future uncertainty distress. Provenzi et al. focus on PRS and links with sleep problems for children born during the pandemic (N=78). Caregiver PRS was positively associated with child sleep problems, but not for those who exclusively breastfed. Mattera et al. found those pregnant during the COVID-19 pandemic (N=117) endorsed greater anxiety and had higher cortisol relative to a pre-pandemic sample (N=151), also reporting greater infant negative emotionality and lower positive affectivity and regulatory capacity two months postpartum. PRS predicted infant negative effectivity, including indirectly through perinatal depression symptoms.

Details

Abstract 1: In Utero Exposure to the COVID-19 Pandemic Increases Infant Negative Affect

The COVID-19 pandemic represents an unprecedented stressor for pregnant and early postpartum people. Yet the effects of in utero exposure to the pandemic, and birthing parent subjective responses to pandemic-related stressors, on infant development remain poorly understood. The current study addressed this gap by examining the extent to which in utero exposure to the pandemic was associated with infant negative affect. Using densely sampled data that captured a variety of objective measures of pandemic exposure (e.g., duration, extent of disruptions), as well as measures of multiple types of subjective responses to pandemic-related stressors (e.g., anxiety, depression, future uncertainty), we examined independent and interactive effects, in an effort to better understanding a) the relative influence of different objective and subjective measures, and b) the interplay between chronicity of objective exposures and intensity of subjective responses in the prediction of infant negative affect. Results have potential to inform intervention designed to support maternal and child health, including in the context of a potentially increasing frequency of natural disasters, pandemics, or other social disruption.

Participants (N=525) were pregnant and early postpartum individuals and their children receiving care through an academic medical center in Portland, Oregon. Birthing parents were 88% White, 9% Latina; on average 33.57 years old (range=18.49-49 years); the median household income was $100-120,000 (range:<$10,000-$250,000+).

Participants provided densely sampled data (every 2 weeks for 12 weeks) during pregnancy and at 1 and 6 months postpartum. Objective measures of pandemic exposure included: length of in utero exposure (the percentage of the pregnancy after 3/11/2020); disruptions to work activities, the number of friends/family who tested positive for COVID-19, and the overall impact of the pandemic on their life (assessed using the COPE-IS; Thomason, Graham, & VanTieghem, 2020). Subjective responses were measured using: Brief Symptom Inventory (Derogatis, 2000) for depression and anxiety symptoms, and the future uncertainty, distress due to social interruptions, and COVID-related distress composites from the COPE-IS. Infant negative affect was assessed using the Revised Infant Behavior Questionnaire at 6 months (Gartstein & Rothbart, 2003).

Hypotheses were tested using structural equation models using Mplus 8.5 (Muthen & Muthen, 1998-2017) with full information maximum likelihood for missing data. Latent curve modeling was used to model trajectories of anxiety and depression across the perinatal period.

Results suggest that infants with greater in utero exposure to the pandemic exhibited greater fear at 6 months of age. Birthing parent subjective responses to the pandemic, and specifically, greater distress due to future uncertainty, were also associated with greater infant fear (Fig. 1). These effects survived controlling for birthing parent postnatal symptoms, as well as demographic variables. Additionally, we found evidence that objective and subjective measures interacted in the prediction of infant negative affect, such that longer in utero exposure to heighted anxiety symptoms (captured by the slope term in our latent curve models) was associated with greater infant fear. This finding provides empirical support for a commonly hypothesized but rarely tested hypothesis that chronicity and intensity of in utero exposure interact in the prediction of offspring adaptation.

Abstract 2: Longitudinal associations between prenatal maternal pandemic-related stress and children sleep problems at 24 months of age is mitigated by breastfeeding

Sleep quality has a significant impact on long-term infants' development and it might be affected by prenatal and postnatal exposures to stress and protective caregiving. The recent COVID-19 healthcare emergency resulted in relevant maternal prenatal pandemic-related stress (PRS) which could have contributed to increase the risk of poorer sleep disturbances in infants. Nonetheless, postnatal caregiving – such as breastfeeding – has been hypothesized to protect and favor better sleep quality.

This study investigated whether exclusive breastfeeding from birth to 6 months of age may act as a potential moderator of the association between prenatal maternal PRS and the risk of emerging sleep problems in 24-months infants born during the COVID-19 healthcare emergency in Italy.

This sample is part of a longitudinal, prospective and multi-centric study on the effects of maternal prenatal PRS on different psychobiological outcomes of infants during the first thousand days, namely the Measuring the Outcomes of Maternal COVID-19-related Prenatal Exposure (MOM-COPE; Provenzi et al., 2020; Provenzi et al, 2021) project. This cohort of mother-infant dyads was enrolled at 10 facilities in Northern Italy. Inclusion criteria were as follows: mastery of Italian language to complete questionnaires autonomously, no significant medical prenatal or perinatal risks, maternal age higher than 18 years and newborns' gestational age ≥37 weeks. Complete data for maternal prenatal PRS were available for 78 mother-infant dyads (50% males). Mothers reported concerning PRS at birth, using the Maternal COVID-19-related Prenatal Stress (MCPS; Provenzi et al., 2020) inventory - a self-report questionnaire that includes 28 items capturing different dimensions of MCPS (e.g., physical exposure, emotional/cognitive disturbance and lifestyle). Exclusive breastfeeding was considered during the first 6 months, and was based on maternal report, with infant sleep problems measured at 24 months using the Children Sleep Habits Questionnaire (CSHQ; Owens et al., 2000). Bayesian analyses were implemented to test a model of moderation by exclusive breastfeeding on the association between PRS and infant sleep quality.

Around 40% of mothers reported continuous exclusive breastfeeding from birth to 6 months. Among tested models, which included the null model, a model with PRS only as a predictor, and a model with additive effects of PRS and breastfeeding, the one including the interaction term between exclusive breastfeeding and PRS provided the best fit indexes. Continuous exclusive breastfeeding from birth up to 6 months of age interacted with maternal PRS in predicting infants sleep problems at 24 months, B= 2.46, with a 90% highest posterior density interval (HPDI) [0.35; 4.54]. Infants who did not receive continuous exclusive breastfeeding from birth to 6 months showed higher sleep problems at 24 months of age at higher (+1SD) levels of maternal PRS.

The present study suggests that continuous exclusive breastfeeding from birth to 6 months of age might be able to attenuate the effects of prenatal exposure to maternal PRS on children sleep problems at 24 months in a sample of infants born during the pandemic. Findings add to the growing literature on the lasting impact of early pre- and postnatal experiences on child development.

Abstract 3: COVID-19 Pandemic Effects: Examining Prenatal Internalizing Symptoms, Physiological Stress, and Infant Temperament

For pregnant women, the COVID-19 pandemic has resulted in unprecedented stressors, including uncertainty regarding prenatal care and the long-term consequences of perinatal infection. Although a growing body of literature suggests pregnant women during the COVID-19 pandemic have experienced greater internalizing symptoms (Ayaz et al., 2020; Berthelot et al., 2020; Moyer et al., 2020), fewer studies have examined whether these findings persist during later waves of the pandemic when less stringent restrictions were in place. Moreover, despite known links between prenatal stress and socioemotional functioning during infancy (Erickson et al., 2017), less information is available regarding these associations during the pandemic. The current study addressed these gaps in the literature by first comparing prenatal internalizing symptoms and infant temperament at two months postpartum collected after the first wave of the pandemic to equivalent measures in a pre-pandemic sample. Second, for women pregnant during the pandemic, the influence of prenatal pandemic-related stress on infant temperament was examined. Third, depression and anxiety symptoms during the perinatal period were examined as mediators of these associations. Data originated from two studies examining the effects of maternal wellbeing during the third trimester of pregnancy on infant temperament at two months postpartum. One sample (N = 151) was collected prior to the COVID-19 pandemic, while women in the second sample (N = 117) were enrolled between January and December 2021. During the third trimester, pregnant women completed self-report measures of depression, general anxiety, and pregnancy-specific anxiety. Women pregnant during the COVID-19 pandemic were also administered a measure of pandemic-related stress. At two months postpartum, mothers completed a survey measuring their infants' temperament as well as measures of depression and general anxiety. A subset of women from both samples collected hair samples at 36 weeks gestation to assess for maternal cortisol levels during pregnancy (Pre-COVID: N = 28; COVID: N = 103). Women who were pregnant during the COVID-19 pandemic endorsed higher pregnancy-specific anxiety (β = .19, p = .007) and cortisol levels (β = .31, p < .001) relative to the pre-pandemic sample. They also reported greater negative emotionality (β = .20, p = .004) as well as lower positive affectivity (β = -.16, p = .03) and regulatory capacity (β = -.20, p = .004) in their infants at two months postpartum. Prenatal infection stress directly predicted infant negative affect (Figure 2a; β = .26, p = .009). Both prenatal infection (Figure 2b; β = .06, 95% CI [.01, .11]) and preparedness (Figure 2; β = .06, 95% CI [.01, .11]) stress indirectly related to infant negative emotionality through perinatal depression symptoms. General anxiety did not serve as a significant mediator of associations between pandemic-related stress and infant temperament. Thus, infants born during the pandemic demonstrated less-optimal temperament development during early infancy relative to those born prior to COVID-19. Pandemic-related stress during pregnancy contributed to greater negative emotionality in these infants, demonstrating the intergenerational impact of prenatal maternal stress during the COVID-19 pandemic on offspring socioemotional development.

S.64 Beyond Qualitative Preferences: Modeling How and Why Infants Direct Their Attention

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Summary

Infants exhibit remarkable control over their gaze. Yet the computational mechanisms underlying this control are not well understood, because most existing studies are limited to descriptions of qualitative preferences. To address this challenge, we present four computational accounts of infants' attention. Each talk will focus on a well-known behavioral measure: looking away from sequences, orienting towards a cued target, or the habituation paradigm. Speakers will present models of these behaviors, which will span multiple levels of analysis: A Bayesian model describing how infants use their gaze to learn, a mathematical model parameterizing infants' learning curves during habituation, and a mechanistic model providing a biologically plausible account of how infants generate saccades. We aim to bridge these levels of analysis to develop a convergent, quantitative understanding of infant attention broadly, and behavioral measures in developmental science specifically.

Details

Abstract 1: infant attention as precision-weighting of prediction errors

It is commonly argued that infants attend to surprising events, defined as stimuli that violate infants' expectations thereby generating prediction errors. Yet, previous findings are inconsistent, as it was reported that infants disengage their attention when stimuli are unsurprising, too surprising, or even in both cases. We will make sense of this conflicting literature by offering a model-based definition of infant attention as precision-weighting of prediction errors. The key idea is that infants are active agents that evaluate the importance (i.e., precision) of the prediction errors they experience, rather than just passively react to them. Thus, attention is not dependent on prediction errors per se, but on how valuable prediction errors are for improving infants' internal models of the world.

This conceptualization of attention makes two key predictions: 1. When the environment is well known, prediction errors are irrelevant and their importance should be downweighed; 2. When the environment is highly uncertain, prediction errors are useful to acquire information, and their importance should be upweighted.

Eight-month-old infants (N = 140) were recruited from a local database of families. In both studies, infants were shown probabilistic sequences of stimuli appearing in different locations on the screen (Figure 1A). The number of sequences and the likelihood of the stimuli locations were manipulated. In study 1, infants were presented with up to 15 sequences of stimuli, all with a (different) high-likelihood location in which stimuli were more likely to appear. This allowed us to generate multiple repetitive environments, where the relevance of prediction errors depleted over time.

In Study 2, infants were presented with only one sequence of stimuli, but we manipulated their high-likelihood location. In stable periods, the high-likelihood location remained the same, while in volatile periods, the high-likelihood location changed unexpectedly. This allowed us to generate uncertain environments, where the relevance of prediction errors was enhanced.

An optimal Bayesian model learned the probabilistic structure of both studies, returning a trial-by-trial estimate of the precision-weighted prediction error of each stimulus. We tested whether the model's estimates predicted infants' attention, as indexed by looking time to the screen in Study 1, and phasic pupil dilation in Study 2.

In both studies, the proportion of anticipatory looks to the correct location was above chance, indicating that infants learned successfully (Study 1: β=.27, SE=.02, 94%HDI=[.24,.37]; Study 2: β=.16, SE=.03, 94%HDI=[.11,.16]). In study 1 (Figure 1B), we found that infants were more likely to look away when the precision-weighted prediction errors were low (β =.065, SE=.019, 94%HDI=[.03,.10]). In study 2, we found that infants were upweighting the precision of their prediction errors when uncertainty was high, as indicated by greater phasic pupil dilation (β =.3, SE=.04, 94%HDI=[.22,.38]). Together, these studies confirm the predictions of our account of infant attention. They clarify the long-standing debate on what attracts infants' attention, and put infants' active efforts in making sense of the world at the center of their early information processing abilities.

Abstract 2: nfant attention as precision-weighting of prediction errors

From birth, human infants engage in learning by looking. Psychologists have long capitalized on this, by probing infants' cognition through analyzing their gaze. Yet, models of infant looking lack predictive detail. To address this, we present an image-computable model, called Rational Action, Noisy Choice for Habituation (RANCH), which predicts infants' looking time in a perceptual learning task.

RANCH consists of three components: First, it perceives stimuli by embedding stimuli into a low-dimensional perceptual space (Lee & DiCarlo, 2023). This makes the model image-computable, allowing RANCH to learn representations from raw images. Second, RANCH learns a perceptual concept by taking noisy samples from these perceptual embeddings. As it takes samples, it refines its beliefs about where in the perceptual space a concept lies. Third, RANCH decides when to stop sampling based on one of two information-theoretic criteria: expected information gain (EIG) or KL-divergence. The number of samples taken by RANCH can be interpreted as an ideal-learner's interest in the stimuli.

To test the model, we developed a new infant looking time paradigm in which we manipulate prior exposure duration and stimulus novelty within-subjects, and assess the effect on looking time. In each block, infants were familiarized with an animated animal for a variable amount of time, and then measured their looking time to either the same animal again, or saw a new animal (Figure 2A). In three experiments, we tested 92 infants, ages 7-10 months, each of which saw up to six blocks. We find evidence for habituation, represented by a decrease in looking time to familiar animals as a function of prior exposure (β=-0.07, t(243.22)=-4.63, p<0.001). Infants also dishabituated, as evidenced by longer looking times after long familiarizations (β=0.54, t(157)=4.49, p<0.001). Interestingly, we do not see evidence for a familiarity preference after short familiarizations, in contrast with predictions made by Hunter & Ames (1988).

We then subjected RANCH to the same paradigm as infants: A series of prior exposures of fixed duration, followed by either the same or a different stimulus. We find that, like infants, RANCH exhibits habituation and dishabituation (Figure 2B). When lesioning RANCH to either not account for its own perceptual noise ("No Noise") or to not base its attentional decisions on learning at all ("No Learning"), we do not recover the pattern of the data. We find that using KL as the sampling criterion achieves a higher fit than EIG (KL: R=0.80, RMSE=2.08; EIG: R=0.71, RMSE=2.43). A noise ceiling, which is the looking time predicted by a simple linear model which, unlike RANCH, has access to the exposure duration and novelty of the stimulus, achieved only slightly better fit than RANCH (R=0.87; RMSE=1.70), suggesting that RANCH performs close to ceiling.

We argue that key characteristics of looking time, habituation and dishabituation, are well described by RANCH, and that RANCH is a general, interpretable and modifiable framework for the rational analysis of intrinsically motivated learning by looking.

Abstract 3: Rethinking habituation, estimating the learning curve

The habituation paradigm has been applied to study the development of memory, perception, and other cognitive processes in preverbal infants, making it one of the most prominent experimental paradigms in infant research. Methodological variations and inconsistency in reporting practices pose considerable challenges to interpreting and generalizing outcomes derived from the habituation paradigm (Zaharieva et al, 2021). Many features of the habituation process itself remain elusive, resulting in uncertainty about the best research practices. We discuss current practices in habituation research (e.g., the use of habituation criteria, e.g. Oakes, 2010) in relation to (statistical) modelling of the process of habituation, revealing several issues that impede progress in the field (Kucharský et al., 2022). This statistical modelling is aimed at estimating critical properties about the habituation process, such as: How many and which infants habituate? What is the shape of the habituation curve? What is the distribution of looking times in habituation experiments?

Some of the issues in using the habituation paradigm are related to specific experimental design choices, e.g. limited duration of trials and infant-controlled paradigms. These design choices interfere with the possibility of estimating these critical properties of the habituation process and can result in biases in the eventual sample. Alternative experimental designs and alternative modelling options are proposed to overcome these issues. Both alternative designs and modelling options should incorporate the full space of possible outcomes, see Figure 1. Infants that do not habituate also provide information about the cognitive processes that underly this process. This is even more the case if the proportion of such infants is sizable, which is frequently the case. We present an i) overview of mathematical modelling approaches (eg Gilmore & Thomas, 2002), that aim to capture the shape of the learning curve, and factors that impact on this, ii) analyze why this approach has not caught on, and iii) propose an outline for an alternative using deep learning approaches to estimating models. Capturing the shape of the habituation curve requires the right mathematical model, should include a mixture component for non-habituators, and properly skewed distributions for the looking times.

Abstract 4: Using dynamic field theory to understand the development of spatial attention

Infant visual attention develops rapidly over the first two years of life, significantly altering the way infants respond to peripheral visual events. Here, we present findings from research using empirical

work and neural process models to understand how covert spatial orienting changes in early development.

In prior work, we used the Infant Orienting With Attention (IOWA) task to examine how covert spatial orienting changes from 5 to 10 months. This task presents a brief (100ms) peripheral cue prior to the onset of a target object. The cue can either be 'valid' (same side as the target), 'invalid' (opposite side), or 'double' (both sides). We also present a control condition with 'no cue'. In addition, similar to the gap-overlap paradigm, a fixation cue can either disappear before the cue (gap / no competition) or remain visible, requiring infants to actively disengage fixation (overlap / competition). Results showed that infants were fastest and most accurate in the valid, no competition condition and slowest and least accurate in the invalid, competition condition. Interestingly, competition effects were most pronounced with 10-month-olds.

We modelled these data quantitatively using a dynamic field model of spatial attention. The model consists of an attentional field and a saccade motor field. The model simulates eye movements to targets within the visual field, capturing both reaction times and accuracy. As reported in Spencer et al. (2022, Infancy), the model did a good job capturing the details of the empirical data across 3 ages and 10 conditions, with an overall RMSE of 37ms for RTs and 0.07 for proportion correct. To capture developmental changes, we used the same developmental parameter values from Ross Sheehy et al. (2015, Infancy), including stronger self-excitation and global inhibition in the attention and saccade motor fields for older infants. This effectively captured the increase in competition effects at 10 months without an explicit disengagement mechanism as has been proposed in the literature.

Here, we focus on current work that overcomes two key limitations of prior work. First, we collected longitudinal data using the IOWA task. One cohort was enrolled at 6 months and visited the lab again at 18 and 30 months; the second cohort was enrolled at 30 months and visited again at 42 and 54 months. Analyses show that key aspects of performance in the task are stable within-individuals longitudinally. For instance, RTs in the double, no competition condition in year 2 predict RTs in the same condition in year 3. Moreover, a competition score in year 1 (competition RTs – no competition RTs) predicted competition scores in year 2.

Our next goal is to model these data. In the past, we have fit empirical data 'by hand'. By contrast, we are currently developing optimisation methods to fit the parameters of dynamic field models automatically. We have successfully fit data from 10-month-olds using these new tools, outperforming the fits achieved 'by hand'. Our goal is to use these new tools to model individual longitudinal trajectories, to better understand the developmental changes in covert spatial orienting.

S.65 Growing social: Early social interactions and parental factors shaping infants' behavioural and emotional processes

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Summary

Despite extensive research, our understanding of the social mechanisms shaping infants' emotional and behavioural processes in the first year of life is still limited. The symposium explores how factors of infants' social environment, including parental smartphone use, social ostracism, and maternal distress and empathy, relate to the emergence of early social competencies. The first talk examines the influence of maternal anxiety and depression on parent-infant interactions. The second describes the effects of maternal smartphone use on infants' behaviour and physiology. The third explores the impact of social ostracism on infants' reactivity and brain responses to emotional faces. The fourth shares longitudinal results on attentional biases and empathic responses, controlling for maternal empathy and depression. Our findings shed light on how early social interactions and maternal characteristics relate meaningfully to broader social and emotional development.

Details

Abstract 1, Title: Parental anxiety and depression during naturalistic play with infants: Active when not needed? Passive when needed?

There is evolving evidence on how parent-infant interactive processes differ as a function of parental depression and anxiety (Smith. et al., 2021; Granat et al., 2017). However, little is known about how these interactive process changes when both depression and anxiety is present in the parent.
At the moment, evidence for how anxiety and depression influence caregiving styles is somewhat conflicting. For instance, existing research suggests a connection between anxious parenting and the behavioural dysregulation in children (Nikolić et al., 2016). Studies focusing on play interactions between anxious parents and their infants have revealed indications of an 'overloaded, highly stimulating' behavioural pattern in anxious mothers (Feldman, 2007). Additionally, these studies have identified elevated levels of behavioural synchrony in such parent-infant dyads (Beebe et al., 2011). For depression, in contrast, there is evidence that maternal depression throughout the postpartum year diminishes social synchrony between the parent-infant dyad and disrupts the development of infant emotion regulation (Granat et al., 2017; Feldman et al., 2009).
The current study explored the differential influences of anxiety and depression by examining associations between parental anxiety and depression levels, and the naturalistic interaction of the mother and the infant. The behavioural coding was based on the Coding of Interactive Behaviour (CIB) manual by Feldman (1998) and obtained from 48 infant-parent dyads who took part in a 6-minute structured tabletop plan interaction in the lab. The coded constructs were the following: dyadic reciprocity, intrusiveness, parent-led play, child-led play, as well as mothers' looks and joining looks to the infant. The parents also completed the depression and anxiety self-report questionnaires, Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder screener (GAD-7) respectively. Median splits were performed to differentiate between high and low levels of anxiety and depression. Subsequently, four groups were generated. The mean age (S.D.) of infants was 323 days (35). Intrusiveness differed across four groups ($F(3,44) = 4.79$, $p = .006$) as well as dyadic reciprocity ($H(3) = 8.04$, $p = .045$). Mothers with LA-LD exhibited lower levels of intrusiveness than mothers with HA-LD and HA-HD. Dyadic reciprocity was highest among the mothers with LA-LD. Mother's looks to the infant were not significant across four groups, however yielded interpretable pairwise outcomes suggesting higher number of mother's looks to the baby among mothers with HA-HD than mothers with LA-HD. Intrusiveness was most prominent among mothers with high levels of anxiety. Dyadic reciprocity was lowest among mothers with high levels of anxiety and low levels of depression. However, high intrusiveness, mother's high number of looks to the infant and low dyadic reciprocity appears to be

Back to top

more specifically associated with anxiety. Anxiety may to bring one to an overly active state when not needed. Can we conclude that depression brings the parent to an overly passive state when needed?

Abstract 2, Title: "Hot stuff": the impact of maternal smartphone use on infant behavioural and affective thermal response

Introduction. Responsive social exchanges are imperative for early infants' bio-behavioral regulation and healthy development. The increase in maternal smartphone use leads to frequent and unpredictable interruptions in mother-infant interactions. Less clear is how these breaks in maternal responsiveness affect infant behavioral and physiological regulation early in life. Infrared Thermal Imaging can provide a non-invasive method to assess stress-related skin thermal changes reflecting affective autonomic processes.
Aims and hypotheses. This ongoing study investigates 3–4-month-old infants behavioral and thermal response to experimentally induced disruptions in mother-infant interactions related to maternal smartphone use. We anticipated maternal smartphone use to be related with an increase in infant behavioural distress and with stress-related autonomic activation reflected in changes in nasal and forehead temperature.
Methods. At 3-4 months of age, mother-infant dyads (n=10, data collection is ongoing) participated in a modified still-face paradigm (Figure 1), comprising five within-subject conditions: 1) Free play, 2) Smartphone distracted, 3) Reunion, 4) Paper distracted, 5) Reunion. During conditions 2 and 4 mothers were asked complete a questionnaire either on a smartphone or in a printed form and to be unresponsive to the infant's bids. The order of these two conditions was counterbalanced in the sample. Mother-infant behaviour and facial skin temperature were continuously recorded using a 360° camera and two FLIR thermal cameras. Mothers and infants' behaviours were microanalytically coded using the Noldus Observer software. Infants' positive and negative affect, gaze, self-comforting behaviours, and social bids across the whole procedure and maternal touch and vocalization during the free play and reunion episodes were assessed. Repeated measures ANOVA were performed to investigate behavioural and thermal variations across the procedure.
Results. Preliminary findings showed reduced positive affect and increased gaze aversion in infants during the smartphone-distracted episode as compared to free play, adjusting for the order of the conditions. Infants also directed more gaze towards the maternal face during the smartphone-distracted episode than the paper-distracted episode. Furthermore, a significant decrease in infant forehead temperature from the free play to the smartphone-distracted episode was observed. Noteworthy, maternal nurturing touch during free play was associated with infant self-comforting behaviours and thermal responses during social interferences. Specifically, infants of mothers exhibiting less touch displayed more self-comforting behaviors and a greater reduction in forehead temperature during the smartphone-distracted episode. Further data on mother-infant coregulation during the procedure will be presented to contribute to the understanding of whether maternal smartphone use can influence dyadic co-regulation processes and potentially affect infant socio-emotional functioning.

Abstract 3, Title: Thrown aside: exploring the impact of ostracism on infants' behavioural reactions and neural processing of emotional faces

Social exclusion, an aversive experience that threatens key psychological needs, such as self-esteem and belongingness (Williams & Nida, 2011) has been extensively studied in adults, revealing physiological, cognitive and behavioural changes and modulation of social information processing (Bass et al., 2014).

However, limited research investigated children and infants' cognitive abilities and behaviour after being exposed to third-party social exclusion (Marinovic & Trauble, 2018), and even less is known about their response to self-experienced ostracism events. As preverbal infants heavily rely on non-linguistic cues, such as emotional faces, during social interactions, the current study aims to investigate 13-month-olds' behavioural reactions to self-experienced social inclusion and ostracism and their impact on the neural processing of emotional faces. Infants participated in a live triadic ball-tossing game with two experimenters, experiencing either inclusion (N=43) or ostracism (N=41). In the inclusion condition, infants received and threw the ball a third of the time, while infants in the ostracism condition only received and threw the ball twice at the beginning and were then ignored for the rest of the game. The ball-tossing game was video-recorded to quantify infants' behavioural reactions to inclusion or ostracism and verify whether they were affected by the experimental manipulation. A subset of infants (N ostracized = 19, N included = 19) had event-related potentials (ERP) recorded while observing dynamic faces expressing fear and happiness. Results on the behavioural reactions during the ball-tossing game revealed that ostracized participants showed a decrease in positive emotionality behaviours (e.g., smiles and happy vocalizations; $p < .001$), more signals of distress (e.g., crying and angry vocalizations; $p = .03$), and more engagement behaviours (e.g., hand banging and pointing; $p < .01$) (Figure 1). Analyses of latency and amplitude values for attentional (Negative central, Nc) and perceptual (P1, N290, P400) event-related potential (ERP) components indicated a faster P1 response to happy faces in the ostracism condition as compared to inclusion condition ($p = .02$). Furthermore, in the inclusion condition fearful faces elicited faster responses compared to happy expressions ($p < .001$), while no significant differences emerged within the ostracism condition (ps > .55) (Figure 2). Current data suggests that the triadic ball-tossing game is a powerful tool to investigate the nature and consequences of ostracism in infancy as it induces heightened feelings of distress and lower positive emotionality in the ostracism condition already at 13 months. In addition, ERP data indicates that first-person ostracism experiences modulate infants' neural processing of emotional expressions and that this modulation varies according to the processed emotion. In conclusion, the present findings demonstrate that ostracism influences infants' involvement in social interactions and their subsequent neural processing of facial emotions. These results will be discussed with respect to the use of the live triadic ball-tossing game as a valid measure for investigating the impact of early ostracism experiences, and the recognition of the need to take a developmental perspective to address the negative affective and cognitive effects of ostracism from early in life.

Abstract 4, Title: Empathy and Externalizing Across Early Childhood: Associations with Infant Social Attention and Maternal Empathy and Depression

Introduction: Infants show robust attentional biases to faces and particularly fearful facial expressions. There is also considerable variability in attention to faces across infants, but little is known whether individual differences in infants' attention to faces associate with broader domains of social and emotional development. Limited number of infant studies indicate that infants' attention to faces and fearful expressions may predict later prosocial behaviors and callous-unemotional traits. In this study, we extend this line of research to investigate whether attention to faces and facial emotions in infancy predicts the development of children's empathy to others' distress as well as callous-unemotional (CU) traits and broader externalizing symptoms. Critically, as these outcomes are also influenced by parenting and genetic transmission, it is important to investigate whether maternal dispositions (self-reported empathy and depression) are associated with the outcomes as well as with infants' attention to faces. Methods: In a longitudinal study (N = 134), attention to faces was measured at 7 and 20 months of age with an eye-tracking paradigm (Overlap task), yielding bias scores reflecting a face bias (looking time to

faces vs. control stimuli) and fear bias (looking time to fearful faces vs. happy and sad faces). Empathy to distress (facial, vocal, and bodily signs of concern and inquiry behavior) was assessed at 7 and 20 months with a pain simulation procedure and a video presentation of a distressed infant. Externalizing symptoms were assessed at 20 months (BITSEA) and at 43 months (CBCL). CU traits were assessed at 43 months (ICU-Preschool). Maternal self-reported empathic concern (IRI) and depression (CES-D) were assessed at 7 months.
Results: A stronger face bias at 7 months was associated with greater empathic responses to distress at 20 months (Figure 1) and lower externalizing symptoms at 20 months (Figure 2). Furthermore, a stronger fear bias at 7 months predicted lower CU symptoms (unemotionality subscale) at 43 months. Attention to faces at 20 months was not associated with the outcomes. Maternal empathy had a small positive correlation with infants' face bias at 7 months. Maternal empathy and depression were not associated with infants' observed empathy, but maternal empathy correlated negatively with children's CU symptoms at 43 months and depression correlated positively with externalizing symptoms at 20 and 43 months. The associations between attention to faces and the outcomes remained largely unaltered when controlling for maternal empathy and depression.
Conclusions: These results provide the first evidence that attentional biases toward faces are associated with empathic responses to others' distress across the first two years. Moreover, elevated externalizing and CU behaviors were linked with reduced face and fear-specific biases in infancy. Controlling for maternal empathy and depression did not abolish these associations. Therefore, infants' attention to faces and empathic reactivity to distress may together reflect a relatively high interest in other people (i.e., social motivation) and a predisposition to utilize facial information for social learning and sharing emotions, which may buffer against the development of aggressive behaviors toward others.

S.66 Learning regularities, generating patterns, and achieving goals: the multi-stage process of applied statistical learning across development.

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Summary

When infants begin life, everything is new, and nothing is expected. As such, they must learn regularities in the environment, in order to interact with it appropriately. Until now, infant sensitivity to patterns has been studied in isolation, separate from the contexts where infants naturally utilise such patterns. Here, we present three contrasting but convergent perspectives that bridge the gap between statistical learning, and how infants apply such learning in ecological contexts. Study 1 shows that infants extract regularities from observed actions, enabling prediction of future states. Next, Study 2 demonstrates how infants actively sample information that reduces uncertainty – by forming patterns in their sequential toy selections. Study 3 demonstrates how toddlers then apply such patterns flexibly, to achieve top-down goals. In sum, this symposium provides a novel perspective on the multi-stage developmental process of reducing uncertainty in an uncertain world.

Details

Abstract 1: TITLE: Statistics in motion: predicting actions based on their transitional probability.

Infants are able to navigate complex environments and extract important information, even though they enter the world with limited knowledge and skills. One of the core mechanisms that supports infants' learning and understanding of their complex environment is statistical learning. This cognitive process allows them to extract patterns and regularities from the sensory information that surrounds them and use this knowledge to form top-down prediction about the environment around them. A key aspect of this is the ability to anticipate others' actions, which shapes social and physical interactions. For example, observing someone reach for a coffee cup naturally leads us to predict that they will take a sip. This predictive ability helps us understand others' goals and mental states (Becchio et al., 2012; Ondobaka et al., 2015). Motor theories suggest that our neural motor system uses prior knowledge and sensory input to predict the behaviour of others. Recently, it has been shown that both infants and adults can detect two deterministically following actions in an action stream and that their motor system uses this knowledge to predict upcoming actions (Monroy et al., 2018, 2019). However, real-life is more complex: actions rarely follow each other with 100% probability.

Here, we test the hypothesis that both infants and adults can pick up different transitional probabilities between actions through observation and that the activation of their neural motor system is modulated by these transitional probabilities. In two studies, 18-month-old infants and adults view videos of unfamiliar action sequences containing four different levels of transitional probability (25%, 50%, 75%, 100%). After watching the videos at home, participants took part in an EEG experiment in which they were presented with an action sequence with the same statistical structure. To assess whether their motor system represents the transitional probabilities of the action sequences, we assess power in the mu and beta frequency band during perceptually identical time windows preceding the actions (see Figure 1).

Although the planned analysis of the infants' data did not reveal a significant effect of probability, in an exploratory analysis, accounting for possible lateralization effects and changes over time, we found that motor activity in the left hemisphere was modulated by the transitional probability of action pairs. Predictive motor activity was strongest when the probability was highest and weakest when no prediction was involved.

In adults, we examined the expectancy and predictability aspects of the statistical structure, which reflect different prediction processes. Expectancy describes participants' expectation of the most likely action, whereas predictability represents all possible actions and their relative probabilities. Our results suggest distinct roles for mu and beta oscillations in action prediction: the mu rhythm showed anticipatory activity unrelated to statistical structure, whereas the beta rhythm corresponded to action expectancy.

In conclusion, these studies demonstrate that infants and adults can discern statistical structures in observed action sequences and utilize this knowledge to form top-down predictions in their neural motor system. This extends prior evidence by showing that motor system activity mirrors the specific statistical likelihood of upcoming actions.

Abstract 2: TITLE: Too random, too predictable, or just right: does toddler construction play show 'Goldilocks' complexity?

To date, research into predictive processing early in development has focused largely on children's sensitivity to predictable patterns (e.g., Monroy et al, 2021), with much less research on how children generate their own predictable structures (e.g., Karmazyn-Raz & Smith et al, 2022; Schroer et al, 2021). Further, to our knowledge, there is no research examining how 30-month-olds develop such routines in a self-motivated manner, i.e., when unconstrained by task goals set by the experimenter.

This paper examines the idea that children's spontaneous toy selections during play are neither completely random nor completely predictable, similar to how they prefer watching material with intermediate complexity (e.g., Kidd et al, 2008). The first aim is to assess whether 30-month-olds are more predictable than chance in their sequential selection of different DUPLO Bricks and Pipe-Building Toys. The hypothesis is that 30-month-olds are predictable. This may be obvious, given that studies of sequential touching show that toddlers select within-category objects repetitively (Mareschal & Tan, 2003). Additionally, 30-month-olds have been shown to build simple towers with DUPLO Bricks which lack complexity (Kaplan et al, 2022). Therefore, it may be the case that toddlers are highly predictable. The second aim is therefore to assess whether 30-month-olds generate sequences that are less predictable than ones simulated to be highly repetitive, i.e., whether they show intermediate complexity. The hypothesis for aim 2 is that 30-month-olds are yet to show intermediate complexity.

This paper will present data from N=60 children aged 28-32 months (M=30.2-months) (current preliminary analyses based on N=10). Children were video-recorded as they played alone with construction toys. Children played with various DUPLO Bricks, and Pipe Building Toys (Fig.1). In both cases, children were presented with 10 pieces each of 6 different shapes of DUPLO Brick or Pipe. Participants were given 12 minutes to play with the toys (mean session length=11.3 minutes). Video recordings of child play were coded for which shape of DUPLO or Pipe toy was selected, giving an ordinal sequence for each child. Entropy of each sequence was calculated, with lower values indicating higher predictability (Shannon, 1948).

To test if children were more predictable than chance, children's sequences were shuffled 10,000 times to create a surrogate distribution at subject-level (Fig. 2C). Across subjects, children were more predictable than surrogate ($p=<0.001$) (Fig. 2D). To test that children were not overly repetitive, 10,000 random sequences were generated from a highly repetitive Markov Chain model (Fig.2A). Contrary to expectation, the group was less predictable than surrogate ($p=<0.01$), indicating that 30-month children in this sample played with intermediate complexity. However, there was a general trend towards toddlers being more repetitive, rather than random (fig.2.B).

This paper presents, for the first time, a characterisation of predictability during unconstrained construction play. In sum, toddlers were predictable, and although they sided towards being repetitive, demonstrated intermediate complexity. Future research will investigate how this predictability changes with age.

Abstract 3. TITLE: Top-down naturalistic action sequence planning of patterns in 24- to 36-month-olds

Infants live in a complex world and must learn to interact with the environment in a systematic top-down fashion to achieve goals. Planning is a complex set of mental and behavioural operations that brings together cognitive, emotional and motivational resources to achieve a desired goal via actions. While the ability to control simple actions improves over infancy (i.e., Gottwald et al., 2016), it is currently unknown whether toddlers can apply patterns sampled from the environment to achieve top-

down goals in multi-action sequences. Moreover, real-world goals can involve multiple constraints simultaneously. The current study investigated (i) the development of top-down naturalistic planning of regularities in a real-world multi-action setting, and (ii) how the planning of real-world multi-action sequences relates to the development of core aspects of executive functions, using a fun and natural task utilising Duplo® blocks.

Twenty 24-month-olds (M = 24.77 months, SD = 12.69 days, 8 females), 20 30-month-olds (M = 30.10 months, SD = 21.23 days, 12 females), and 30 36-month-olds (M = 36.50 months, SD = 19.20 days, 18 females) participated in this study. Toddlers completed a novel planning task – building a striped Duplo® tower subject to two constraints: (1) build a tower to a certain height, and (2) make it striped by alternating between two different block colours (Figure 1). Furthermore, assessments of working memory updating and response inhibition were executed using standardised tasks for this age group; i.e., working memory updating using the spinning pots task (Hugh & Ensor, 2005) and response inhibition using the magic wand task (Friedman et al., 2011).

Results revealed no age effect on the ability to achieve the constraint of height (X^2 (2) = 5.12, p = .063). However, a stepwise linear regression did show that older toddlers were more successful than younger ones at adhering to the striped constraint (F(1,56) = 15.03, p < .001). Similarly, only in the oldest age group (36-month-olds) was performance on the striped constraint significantly related to performance on the height constraint (X2(1) = 8.31, p = .004), demonstrating that children who succeed on the height constraint were more likely to also score highly on striped constraint. In summary, these results illustrate how toddler's real-world multi-action top-down planning in the context of multiple goal constraints and their ability to use patterns sampled from the environment in multi-action planning improves from 24- to 36-months.

We also investigated whether EF scores predicted performance on the planning task. While inhibition was predicted over and above age group by height constraint performance (X^2 (1) = 4.43, p = 0.35, Nagelkerke R^2 = .251, Figure 2A), working memory was predicted significantly by success on striped constraint (F(1,56) = 7.96, p = .007, Figure 2B). Children who built the tower to the correct height were more likely to succeed on the inhibition task, while a higher proportion striped (striped constraint) was associated with a higher working memory score. This suggest that working memory updating and response inhibition are differentially impactful on the development of planning abilities in 24- to 36-month-olds.

S.67 Moment by moment: The timing and structure of natural behavior

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Summary

Behavior, like development, unfolds over time in contexts that structure what babies do, when, and with whom. The four talks in this symposium, delve into the timing and structure of natural behavior—across different developmental domains, in the home or the lab—to inform on the organization of spontaneous infant-caregiver interactions. Talk 1 measures the timing of mothers' labels in response to infant object interactions at home and tests the effect of label timing on infant word learning in the lab. Talk 2

quantifies the temporal structure of mothers' speech to infants at home to test whether the timing of words provides infants with information to support category learning. Talk 3 examines how environmental and social factors shape infant walking and play behaviors during unstructured play in the lab. Talk 4 documents how mothers and infants use technology at home, and how the structure of media use relates to children's emotions before and after media activities.

Details

Abstract 1 Title: Perfect timing: Connections between infant actions, noun input, and noun learning

Infants' motor skill acquisitions often precede and predict advances in their language learning. For example, word learning accelerates when infants begin to walk (Walle & Campos, 2014; West et al., 2019). Yet, little is known about the real-time mechanisms by which infants' motor behaviors facilitate their word learning (if they do at all). We propose that temporal connections between infant action and caregiver language support word learning. Specifically, we hypothesize that: (1) caregivers synchronize their noun use with infants' moment-to-moment actions (e.g., caregiver says, *"crayon"* precisely as baby draws with crayons) and; (2) this synchrony helps the infant connect the word to its referent. We present data from two complementary studies. Study 1 leverages observational data to document temporal connections between infants' actions and their noun inputs during daily life. Study 2 experimentally tests whether temporal synchrony between infants' actions and noun inputs facilitates their word learning.

Study 1 (*N* = 20) documented caregivers' noun use during at-home naturalistic observations longitudinally from infant ages 10- to 14-months-old. When infants manipulated objects, caregivers contingently responded with nouns that pertained to the object. For example, if infant held a toy car, caregiver said words like *"car"* or *"wheels".* Caregivers' utterances contained a higher proportion of noun labels during infants' object manipulation (*M*=0.35, sd=0.6) than when infants were not holding anything (*M*=0.25, sd=0.09). Moreover, as infants developed, caregivers increasingly synchronized their noun use to infant actions.

Study 2 tests whether noun-action synchrony facilitates infants' real-time learning (*N* = 13 collected, 60 planned; ages 30-39 months). The experiment consists of two phases: a play session followed by test trials. During the play session, infants play with five novel "toys" that are fabricated to be unfamiliar (i.e., they are items that infants would not encounter in daily life). Each toy has a corresponding novel name (e.g., *"dax"*). An experimenter and the infant play together with the toys for 5 minutes, during which time the experimenter labels each toy 6 times.

The critical manipulation is *how* the experimenter labels the toys during the play session. Infants are semi-randomly assigned to groups (Figure 1). Infants in the action cues group hear the labels synchronously with their actions. The experimenter labels each toy precisely as the infant manipulates it (*"the dax is green"* as infant holds the dax). (2) Infants in the social cues group hear the label synchronously with the experimenters' social cues. The experimenter labels each toy while gesturing and looking to the target object (*"the dax is green"* as the experimenter points to the dax). (3) Infants in the comparison group hear the same language verbatim, but without context cues. Afterwards, we test whether infants learned the nouns across 15 trials. We hypothesize that infants in the action cues group will learn more nouns compared to the other groups.

Study 1 establishes an ecologically valid, real-world connection between infants' actions and opportunities to learn nouns. Study 2 constitutes the first experimental test of whether infants' actions facilitate their word learning in the moment.

Abstract 2 Title: Rhythm of words: The temporal structure of mothers' everyday speech to infants encodes semantic categories

Growing a vocabulary is more than simply learning words. As infants build their vocabulary, they create rich semantic networks—connections among words based on meaning. Infants evidence semantic connections between words by the second year. What factors account for infants' ability to establish semantic connections among like-type words? Past work suggests that infants leverage perceptual information (e.g., objects with the same shape belong in the same category) as well as information about the superordinate (e.g., objects with the same name belong to the same category). Here we propose an additional mechanism—that the speech that caregivers direct to infants may contain sufficient structure to allow babies to extract meaningful category membership.

To test this question, we videorecorded 78 mothers interacting at home with their 13- to 23-months-olds (36 female). Each dyad was observed for one to two hours, for 129.58 hours of everyday activities in aggregate. Videos were transcribed with each utterance time locked to the millisecond. Across transcripts, mother used 355,334 total words and 8,064 unique words. The 8,064 unique words were sorted into 21 semantic categories (Table 1). We hypothesized that categories of words entrained by activity (e.g., feeding verbs) and words from early-learned taxonomic categories (e.g., vehicle names) will occur closer in time than expected by chance whereas words from other categories (e.g., large household objects) will not.

To quantify the temporal structure, we calculated latencies between each word and every subsequent word within each semantic category, including word repetitions (semantic latencies; e.g., cat-to-dog and cat-to-cat). Additionally, we calculated latencies between all of the words regardless of category (baseline latencies; e.g., cat-to-train).

We plotted semantic latencies and baseline latencies. If words were evenly spaced, rather than temporally clustered, the distribution of latencies across dyads would resemble a triangle shape. If words occurred in tight proximity, the distribution of latencies would show a sharp peak on the left side, reflecting more adjacent words at tighter time windows.

Baseline latencies between all words followed a similar pattern to what would be expected if words were generally evenly spaced. In contrast, semantic latencies followed a pattern to what we would expect if words clustered together. A Kolmogrov-Smirnov test confirmed this difference in distributions across the sample (all p's < .001), which was driven by the frequency of short latencies, as confirmed by a two-proportion z test (all p's < .001). The effects were strongest for those categories entrained by activity and early learned taxonomic categories (Figure 1). Furthermore, the observed effects seen across dyads were replicated when data from individual mothers were analyzed.

Infants learn categories by leveraging the information available to them in the environment, including shapes and labels. By examining the natural behavior of infant and mother at home over long periods of time, we identified additional information available for infants in their environment—the temporal structure of words within a category.

Abstract 3 Title: Developmental changes in infant locomotor exploration

The onset of independent walking is widely recognized as an important milestone in the development of exploratory behavior. But prior work suggests that, at least for newly walking infants, most bouts of locomotion don't end at something new. Here, we asked whether infants' tendency to walk to new objects is influenced by social and environmental factors and whether these object discoveries change with walking experience.

We observed 40 12- to 22-month-olds during free play and recorded how often they walked to new objects. We considered an object "new" if it was out of reach when infants started walking but was within reach when infants stopped walking. All infants played in two social conditions (alone or with a caregiver) crossed with two environmental conditions (access to gross- or fine-motor toys) for a total of 4 conditions (8 min/condition; Figure 1A-C). Parental reports of infants' walking experience ranged from .33 – 10 months and were corroborated with a standard assessment of walking proficiency.

To test whether the rate of object discovery differed by condition or changed with walking experience, we calculated the number of walking bouts that ended at a new object per minute. When infants played with toys designed to encourage walking (i.e., gross-motor toys), they discovered new objects more frequently than when they played with toys designed to encourage stationary play (i.e., fine-motor toys; Wald $X^2 = 47.45$, $p < .001$; Figure 2A). Playing with a caregiver further exaggerated the effects of the toy conditions (Wald $X^2 = 24.02$, $p < .001$; Figure 2A). When infants played with gross-motor toys, they discovered objects more frequently when they played with their caregiver than when they played alone ($p < .001$). However, when infants played with fine-motor toys, they discovered objects less frequently when they played with their caregiver than when they played alone ($p < .001$). In all conditions, the rate of object discovery increased with walking experience (Wald $X^2 = 8.69$, $p = .003$).

To test for changes in the efficiency of object discovery, we calculated the proportion of infants' walking bouts that ended at a new object. Adjusting for overall rates of walking, when infants moved, they were equally likely to go to a new object in both toy conditions (Wald $X^2 = 3.11$, $p > .05$; Figure 2B). Playing with a caregiver increased infants' locomotor efficiency in both conditions. When playing with their caregivers, a greater proportion of infants' walking bouts ended at a new object than when they played alone (Wald $X^2 = 4.43$, $p = .04$; Figure 2B). In all conditions, the proportion of bouts ending at new objects increased with walking experience (Wald $X^2 = 4.39$, $p = .04$).

Thus, we find that playing with gross-motor toys and a caregiver encourages object discovery whereas playing with fine-motor toys and a caregiver encourages interaction with fewer objects. More experienced walkers went to new objects more frequently and more efficiently than less experienced walkers, suggesting that over development, walking becomes increasingly directed toward discovering new things to explore.

Abstract 4 Title: Left to their Own Devices: A Naturalistic Examination of Media Use during Mother-Infant Play

Although parents are concerned about the effects of media on children, little is known about young children's everyday media use. Early media use has traditionally been examined in lab-based studies (Kirkorian et al., 2009) or using semi-observational studies in public spaces (Radesky et al., 2014) and the

home (Fidler et al., 2010). The current study examines spontaneous use of media during unstructured time at home, to examine if digital media use enhances or disrupts play quality.

Early interactions with caregivers play a critical role in children's development, but devices often shape these interactions. Technoference occurs when devices interrupt interactions (McDaniel, 2015). Previous uses of the term focus on mobile device use intruding on social interactions, but early work on background television describes media-interrupted attention in similar ways (Kirkorian et al., 2009). Intrusions may be especially impactful for infants whose mothers' attention is regularly pulled away by a screen (Konrad et al., 2021).

In contrast, joint media engagement (JME) occurs when children and caregivers share a screen. Coviewing, a type of JME, has been shown to support children's word learning (Strouse et al., 2018). When engaged in digital play together, mothers may focus children's attention and enhance their play experience. Based on the prior literature, we hypothesize that play quality will be disrupted most during technoference or background media, and least disrupted by JME.

This exploratory study extends an analysis of the existing Science of Everyday Play dataset (Tamis-LeMonda & Adolph, 2017). Recorded observations were collected in the homes of mothers and their 12-, 18-, or 24-month-old infants (n = 48). A media behavior protocol was developed to measure solo child device usage, joint media engagement, mother device usage (technoference), and background media usage, as well as children's emotions just before and after media use, mothers' engagement with their device, and interactions during media use. Coders trained to reliability on a training set of videos, reaching inter-rater intraclass correlation coefficients (ICC) of .9; 30 percent of the dataset has been coded. While an observer effect from the collection protocol may artificially reduce mothers' media behaviors, this study allows us to better understand patterns of media use in the home.

Of the first 14 dyads, 4 used no media at all. Ten mothers used media alone spending an average 3.1 minutes on a device. Only four children used media at all for an average of less than one minute in joint media engagement and solo device use (Table 1). Background media was the most frequent. Children's solo media use included pretend phone calls and asking smart speakers to play music, which then played in the background of other activities. Additional qualitative coding has begun and will provide insights into how media use is initiated during these sessions. When coding is completed in early 2024, we will further examine relations between the four media use types, interactional quality, infant age, and temperament.

S.68 Distribution of Attention to People versus Objects: Converging Evidence from Diverse Samples

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Summary

Attention is a selective process that helps infants, children, and adults process and respond to complex environments. The distribution of attention to people versus objects varies across development as well

as across individuals. Evaluating the distribution of attention to people versus objects across diverse samples has the potential to yield insights into developmental processes. Presentation 1 uses head-mounted eye-tracking to examine frequency and duration of visual sampling of faces and objects in young children with Down Syndrome during parent-child interactions. Presentation 2 tested associations between distribution of attention to people and objects and attention control in term and preterm infants. Presentation 3 investigated gaze orientation during mother-child free play interaction in infants with neurodevelopmental disabilities. Together the three presentations and discussion consider insights from this converging evidence from diverse samples.

Details

Abstract 1: Visual sampling of faces and objects during parent-child interaction in young children with Down syndrome

The sampling of visual information in everyday environments is a crucial building block for interaction and learning. Traditionally, young children with Down syndrome (DS) have been described as over-relying on social agents and engaging with objects less compared to their typically developing (TD) peers. Furthermore, children with DS were found to have slower reaction times and slower disengagement in screen-based eye-tracking tasks (for review, see D'Souza & D'Souza, 2023). Here we utilise dual head-mounted eye-tracking during free-flowing parent-child interaction to examine frequency and duration of visual sampling of faces and objects in young children with DS.

Fifteen TD young children (17-27 months) were matched on mental age to 15 children with DS (36-58 months).

Together with their parents, the young children took part in the head-mounted eye-tracking study of parent-child interaction (6 minutes) with novel objects and their labels. The data was coded frame-by-frame for visual regions of interest. This enabled us to examine instances of face looks and object looks. Children were also administered the Mullen Scales of Early Learning (MSEL; Mullen, 1995) to measure their mental age.

We examined the effect of agent (parent vs child), group (DS vs TD), and target (face vs object) on median look duration and number of looks (see Figure 1). Contrary to general expectations, there was no significant main effect of group and no interaction. In other words, the dyads with young children with DS did not differ from TD dyads in how often and for how long they sampled faces vs objects. However, there was a significant main effect of agent. Parental looks to faces and objects were shorter ($F(1, 56) = 37.02$, $p < .001$, partial eta squared = .40) and there were more of them ($F(1, 56) = 92.47$, $p < .001$, partial eta squared = .62) than child looks. Finally, there was a main effect of target. Looks to faces tended to be longer ($F(1, 56) = 3.50$, $p = .067$ [trending], partial eta squared = .06) and there were fewer of them ($F(1, 56) = 107.73$, $p < .001$, partial eta squared = .66) than looks to objects.

Contrary to general expectations, we did not find any differences between dyads with children with DS and dyads with TD children in terms of how often or for how long they visually sample objects and faces. However, overall, parents demonstrated more agile visual sampling abilities than children, perhaps as a result of attentional gains over developmental time. This makes them flexible partners, well equipped to monitor and adjust to their children's behaviours. Furthermore, we need to better understand what purpose looks to faces vs objects serve, as their different duration and quantity suggests their function

may be different. This line of research will inform our theories of naturalistic visual sampling as well as provide insights for parents and practitioners into how to better support young children with DS.

Abstract 2: Attention control in preterm and term 5-month-old infants: Distribution of attention and cross-task stability

Cross-task stability refers to performance consistency across different settings and measures of the same construct. The study of cross-task stability can help us understand developmental processes, including how risks such as preterm birth affect outcomes. We investigated cross-task stability of attention in 32 preterm and 39 term infants who completed an experimental attention following task with a researcher and a naturalistic play observation with their mothers. This design allowed us to test associations between infant's attention control and their distribution of attention to people and objects during naturalistic observations.

All infants had the same chronological age at time of testing (5 months) but varied in gestational age at birth. All N=71 infants (30 females) were aged 5 months (± 15 days) from birth. Preterm infants' gestational age (GA) was 30 to 36 weeks (M = 34.16); Term infants' GA was 37 to 42 weeks (M = 39.88).

During the attention following task infants sat in front of an experimenter who held two puppets, one near each shoulder. The experimenter attracted infants' attention by talking and then turned to one puppet, keeping this posture for 7 s while still talking in infant-directed speech. This procedure was repeated for a total of four trials alternating the side of turns in a pre-determined sequence. We evaluated three response types. No Turns were trials where infants did not shift their gaze from the researcher's face. Correct Turns were trials where infants turned to the same side as the experimenter. Checking Back were trials where, after a Correct Turn, infants looked back at the experimenter. While No Turns indicate difficulties with disengagement, Checking Back trials indicate infants' flexible attention control.

Infants also completed a 15 min play session with their mothers. We provided age-appropriate toys and asked mothers to play as they did at home. We considered infants' Attention to Objects defined as the proportion of the interaction that infants spent in object-oriented attention.

Both preterm and term infants displayed a higher rate of Correct Turns than expected by chance (48% and 42% respectively), demonstrating attention following. However, preterm infants had more difficulties with disengagement: they displayed a higher rate of No Turn trials (30%) compared to term infants (18%). Furthermore the likelihood of No Turn trials decreased with increasing gestational age. Gestational age was positively associated with Attention to Objects. Analyses of cross-task stability indicated that Checking Back in the experimental task was positively related to Attention to Objects in the naturalistic observation, ? = 0.19, but the strength of this association increased with gestational age, ? = 0.24.

Flexible attention shifts in the experimental task were positively related to attention to objects in the naturalistic observation. Furthermore, infants of older gestational age displayed stronger associations between attention control in the experimental task and attention to objects in naturalistic observations, thus demonstrating cross-task stability. Our study provides initial evidence that the consolidation of attention control increases with gestational age and highlights the value of comparing experimental and observational measures of attention.

Abstract 3: Investigating the role of maternal sensory input in orienting to mothers and objects in children with neurodevelopmental disabilities during free play

Infants with neurodevelopmental disabilities (ND) are a heterogeneous population characterized by a range of clinical diagnoses associated with different deficits (Ismail & Shapiro, 2019). Although the diagnostic framework may vary, children with ND share reduced socio-relational abilities (Giusti et al., 2018). In healthy infants, one of the key components of mother-child interactions is gaze orienting (Nied?wiecka et al., 2018). Gaze orienting may be impaired in ND infants (Sargent et al.,2013), which further challenges the quality of social bonding. In the face of such impairment, parents may use alternate strategies, such as sensory stimulation, to get in contact with their infant with ND.

The aims of our study were: (1) to investigate gaze orientation during mother-child free play interaction in infants with ND; (2) to evaluate whether maternal sensory stimulation is associated with gaze orienting in infants with ND.

Sixteen children (6 females) with ND aged 13-21 months (M = 18.19, SD = 2.61) were compared with 16 typically-developing children (TD) (6 females) aged 11-24 months (M = 18.25, SD = 3.91). TD children were pair-matched with children in the ND group by sex and age (±2 months). A 10 minute free play interaction was videotaped for behavioural coding. Two independent coders coded child's gaze orientation (mother-directed gaze, object-directed gaze) maternal affective (touch that gives a sense of closeness; it is delicate, soothing, slow.) and playful (touch that appears active, repetitive, high-energy and fast as tickle squeeze, move the infant's body to make the infant smile or laugh.) touch and maternal affective and playful voice in 2s intervals.

Mean occurrence (reported as proportion of time) of: (a) mother-directed gaze was .08 (SD = 0.95) and 0.12 (SD = 0.13) respectively for infants with ND and infants TD, t(30) = ?.90, p?=?.375; (b) object-directed gaze was .68 (SD =0.21) and .82 (SD = .12) of time respectively for ND and TD children, t(30)?=?-2.18, p?=?.019. In Infants with ND Pearson's correlations showed that: (1) maternal playful vocalization positively correlated with mother-directed gaze (p <. 001); (2) maternal playful touch positively correlated with mother-directed gaze (p <. 013) and negatively with object-directed gaze (p = .009); (3) maternal affective touch negatively correlated with object-directed gaze (p <. 012). In Infants with TD Pearson's correlations revealed that: (1) maternal playful vocalization positively correlated with mother-directed gaze (p =. 003) and negatively correlated with object-directed gaze (p = .18); (2) maternal affective touch positively correlated with mother-directed gaze (p <. 018).

Our results confirm previous findings on gaze orienting in infants with ND. Both in children with ND and in children with TD, caregiver playful vocalization seems to play a role orientating visual attention to their interactive partner (i.e., the mother). In children with ND playful touch, rather than affective touch (as we observe in infants with TD) seems to support infant's visual attention to their mother. Therefore, it seems that for infants with ND playful sensory input, that are characterized by rhythmic high-energy and high-paced stimulations, represent a key reinforcement for social orienting.

Oral Abstracts

O.01: Word Learning

O.01.01 - Revisiting the informativity of observational contexts for early-learned hard nouns

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Details

One prominent account of infant vocabulary acquisition is that the process by which infants learn “easy words” (words like “ball” that denote concrete objects) and “hard words” (words like “story” that denote more abstract concepts) differs. Whereas acquiring the meanings of easy words relies primarily on the observational contexts in which those words occur, acquiring the meanings of hard words relies more on access to their linguistic contexts (see Gleitman et al., 2005). The current study asks whether the tasks previously used to assess the informativity of observational contexts may have underestimated their role for learning one type of hard word (nouns that denote non-basic level object categories, or “hard nouns”; see Kako, 2005). Using a new paradigm, the current study reveals that whether observational contexts can support learning hard nouns depends critically on how learning is measured.

Methods

In a three-phase task, 120 adults assessed the informativity of observational contexts for one of ten hard nouns learned early in development (“dinner”, “friend”, “hand”, “morning”, “school”, “story”, “tomorrow”, “toy”, “water”, “wind”; Fenson et al., 2007). In the Categorization Phase, participants saw 32 scenes from young children’s picture books that either did or did not contain the hard noun in its text (all text was removed; see Fig. 1). For each scene, participants guessed whether the scene contained a “mystery noun” (represented by the novel word “MODI”). To assess learning over time, participants received feedback for each guess. Participants then completed a Word Identity Test, in which they guessed the mystery noun’s identity. Finally, participants completed a Semantic Relatedness Test, rating the similarity of “MODI” to the target noun and the other nine hard nouns.

Results & Discussion

Comparable to previous work (Kako, 2005), only 18% of participants correctly guessed the mystery hard noun in the Word Identity Test. The novel contributions of this study are in highlighting the partial knowledge of hard noun meanings that participants acquired. First, even though most participants guessed incorrectly in the Word Identity Test, the errors participants made for the relevant target nouns were rated (by a separate group of participants) as closer in meaning to that target noun than errors for the study’s other nouns, $t(109) = 8.21$, $p < .001$ (Fig. 2A). Second, participants who guessed incorrectly in the Word Identity Test nonetheless performed above chance in the Categorization Phase, $t(97) = 4.14$, $p < .001$ (Fig. 2B). Finally, participants who guessed incorrectly in the Word Identity Test nonetheless rated the mystery noun as closer in meaning to the target noun than to the other nouns, $t(97) = 6.45$, $p < .001$ (Fig. 2C).

These results suggest that although the observational contexts of hard nouns may not lead learners to *exact* word meanings, these contexts appear to be sufficiently informative to lead learners to the right semantic neighborhood. We propose that understanding the contributions of different sources of information for learning a broad range of words requires detailed consideration of the tasks used to assess, and thus our definition of, learning.

O.01.02 - The comparison of similar than varied events helps Japanese- and English-speaking children learn verbs

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Details

Learning verbs is an important part of learning one's native language. Verb learning mechanisms may differ across languages and cultures, which is why recent research has compared novel word learning in various languages (e.g., Childers, Paik, Flores, Lai & Dolan, 2017; Imai, Li, Haryu, Okada, Hirsh-Pasek, Golinkoff & Shigematsu, 2008). However, the comparison of multiple events during verb learning is a general cognitive mechanism that could be used across languages. Prior studies have shown that children younger than five years can have difficulty learning and extending new verbs when a verb is presented only with a single example event (e.g., Imai et al., 2005; 2008).

The current study includes children in Japan and the US to better understand verb learning across different linguistic features and cultural patterns. Additionally, it extends prior studies by providing children with multiple events during learning and manipulating the similarity of the objects in these events. Japanese- (n= 139) and English-speaking (n= 180) two-, three-, and four-year-old children (similar Ns at each age per language) were asked to learn and extend novel verbs. In the high alignable condition, children first saw two events with similar objects, then saw an event with a dissimilar object. In the low alignable condition, children saw all three events with dissimilar objects. According to structure mapping theory (e.g., Markman & Gentner, 1983), children in the high alignable condition should perform best as the order of presentation of the three events (similar first then dissimilar) is likely to induce progressive alignment (e.g., Gentner & Namy, 2006). After the learning phase, children saw two test trials and were asked to point to one of two scenes to extend the verb in two test trials; this process was repeated for four sets.

A repeated measures ANOVA shows a significant Age by Condition interaction, $p < .03$ (see Fig. 1). In contrast to prior results, four-year-olds in both languages did well in both conditions and across test trial types. Three-year-old children, especially in Japanese, performed best in the high alignable condition, showing experience seeing two events with similar objects before one with a dissimilar object was useful for verb learning. The two-year-old children mostly struggled in this task.

These are new findings, showing that multiple events inviting progressive alignment would lead 3-year-olds to learn and extend novel verbs across in two linguistically distant languages. This study shows many similarities between children's learning of verbs in English and in Japanese. Given optimal sentence frames, children in both languages benefitted from progressive alignment. These findings show a key mechanism for verb learning- the comparison of events- is useful across languages.

O.01.03 - Infant vocabulary composition following cochlear implantation predicts long-term language outcomes

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Details

Although vocabulary size has long been seen as an index of infants' developing language abilities, an increasing body of work suggests that the composition of an infant's vocabulary, particularly with respect to the proportion of shape-based nouns (e.g., cup, spoon) indexes key mechanisms supporting language development. Early-learned English vocabulary is dominated by shape-based nouns, and the proportion of these words in infants' vocabularies appears to affect subsequent word learning, later vocabulary size, and linguistic proficiency (Perry et al., 2023; Perry & Saffran, 2017). Here we test whether vocabulary composition affects future language development for infants with hearing loss who use cochlear implants (CIs). Infants with hearing loss who use CIs begin to learn spoken language following a period of auditory and linguistic deprivation that leads to language delays (Ganek et al., 2012; Niparko et al., 2010). Thus, infants with CIs receive increased access to auditory information at a specific point, providing a fixed point at which spoken language development begins. This provides an experiment in nature for understanding how early vocabulary composition shapes subsequent word learning and language development in the context of the clinical provision of auditory experience.

We examined initial vocabulary composition in a large sample of infants with hearing loss following cochlear implantation (n=164; *M*=3.0 years old at study start), which provides auditory experience to infants with hearing loss, and age matched controls with normal hearing (n=90; *M*=2.9 years old at study start). Data were drawn from the Childhood Development after Cochlear Implantation (CDaCI) study, which is a multi-center, national cohort investigation of the effectiveness of CIs in deaf infants in relation to their hearing peers (Fink et al., 2007). At the study start, 6 months post-implantation, we measured the proportion of shape-based nouns in infants' vocabularies, as measured by the MacArthur-Bates Communicative Development Inventory III (MCDI III). We then predicted vocabulary size (on the MCDI III) and receptive and expressive language abilities (on the Reynell Developmental Language Scales) at follow-up visits 12, 24, and 36 months after cochlear implantation.

We found that at the study start, infants with CIs (*M*=7.87 words, SD=19.37) had a smaller overall vocabulary size than infants with normal hearing (*M*=59.02 words, SD=35.61), $t(248)= -12.45$, $p<.00001$. The proportion of shape-based nouns in their vocabularies (*M*=.28, SD=.41) was also smaller than that of infants with normal hearing (*M*=.67words, SD=.22), $t(248)=-9.88$, $p<.00001$. However, a series of mixed-effects regression models revealed that in general, infants who had higher proportions of shape-based nouns at the study start subsequently had larger vocabularies (**Figure 1**) and scored higher on

standardized tests of receptive and expressive language abilities (**Figure 2**) at the follow-up visits than infants with lower proportions of shape-based nouns in their starting vocabularies *ps*<.00001. These effects were stronger for cochlear implant users, especially 24- and 36-months post-implantation as evidenced by significant interactions between group, visit, and the effect of shape-based nouns *ps*<.00001. Together the results suggest that learning shape-based nouns facilitates infants' language development and appears to counteract the initial language delays of cochlear implant users.

O.01.04 - Night sleep, parental bedtime practices, and language development in low-risk preterm and full-term late talkers in the third year of life

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Details

Night sleep patterns change across the first years of life (Sadeh et al., 2009), with differentiating trajectories between typical and at-risk populations (Scher et al., 2008). Parental bedtime practices also change over time, impacting children's night sleep patterns (Morrell et al., 2002). Some studies also showed that night sleep and parental bedtime practices are linked to language development (Dionne et al., 2011). Despite that, very few studies have investigated developing sleep patterns and parental bedtime practices and their association with language development in populations at risk for language delay, such as infants born preterm and late talkers. This study aimed to investigate whether low-risk preterm and full-term late talkers differed in night sleep (total night sleep difficulties, settling, night waking, co-sleeping) and parental bedtime practices (total parental bedtime practices, active physical comforting, encouraging autonomy, leaving to cry) from 30 to 36 months and whether these changes were associated with the development of vocabulary and sentence production. Parents of 38 late talkers, born either low-risk preterm (GA< 37 weeks; n= 19) or full-term (GA≥ 37 weeks; n= 19), without neurological disorders, sensory or motor impairments, or severe cognitive deficits, filled out the Italian versions of the Infant Sleep Questionnaire, the Parental Interactive Bedtime Behaviour Scale, and the MacArthur-Bates Communicative Development Inventory Words and Sentences-Long Form at 30 and 36 months. Total night sleep difficulties, settling, and night waking decreased in both groups from 30 to 36 months, revealing a significant age effect. A significant group effect was found in total night sleep difficulties, night waking, and co-sleeping with higher scores in low-risk preterm than full-term late talkers. In addition, a significant interaction between age and group emerged in total night sleep difficulties, with greater recovery in low-risk preterm late talkers. Concerning parental bedtime practices, active physical comforting and leaving to cry significantly decreased in both groups from 30 to 36 months, although active physical comforting remained significantly higher in low-risk preterm than full-term late talkers. Multiple

linear regressions revealed that an increase in total parental bedtime practices, particularly encouraging autonomy, from 30 to 36 months, was associated with increased sentence production, over and beyond night sleep difficulties and neonatal status. Findings pointed out an age related improvement in late talkers' night sleep and a decrease in parental bedtime practices that do not promote autonomy. Low-risk preterm talkers continued to show more night sleep difficulties than full-term peers, even if a recovery was observed. In addition, the present study underscored a link between parental bedtime practices and language development, specifically, an increase in encouraging autonomy bedtime practices (e.g., singing, reading) was associated with increased sentence production by late talkers. These results have relevant clinical implications in terms of monitoring and implementing interventions directed at preterm and full-term late talkers' night sleep and their parents' bedtime practices, which may positively affect night sleep quality and language development.

O.01.05 - How do touch-and-feel 'first words' books affect infants' word learning?

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Details

Objective

Infants may struggle to learn from educational 'first words' books due to difficulty understanding that pictures can symbolise real-world objects (DeLoache, 2004). Indeed, previous work suggests that less iconic pictures (e.g., drawings rather than photos) and manipulative features (e.g., pop-up, lift-the-flap) hinder infants' learning by hampering this symbolic insight (Ganea et al., 2008; Shinskey, 2020; Tare et al., 2010). However, scant research investigates the effect of picture books' tactile features on infants' learning of the words in the book. Furthermore, previous research has been lab-based, raising questions about generalizability.

We conducted two studies to address these gaps. We hypothesized that infants would show poorer word learning and generalisation to real-world objects from picture books with 1) "touch-and-feel" texture vs. no texture, and 2) drawings vs. photographs.

Methods

Study 1 tested 48 British 17-month-olds using a commercial book of animal photos with vs. without "touch-and-feel" texture. During book-sharing, we labelled the target animal with a non-word 12 times. We then tested learning and generalization with picture trials and object trials (scale models and stuffed animals) by pairing the target with a distractor and asking infants for the target by name. We scored videos for whether or not infants chose the target (1 or 0) and for their interest during book-sharing.

Study 2 tested 138 sixteen-month-olds more naturalistically with parent-infant dyads sharing at home for 6 weeks a book about clothing introducing four unfamiliar words. There were five book groups: textured photos, textured drawings, untextured photos, untextured drawings, and control (Figure 1). We then tested learning and generalization of the four words with picture trials and object trials as in

Study 1. Parents also reported on infants' word knowledge on the UK-CDI and on infants' interest during book-sharing. Study 2's data have been collected and are being analyzed.

Results

Study 1's textured-book group learned the novel label but did not generalize it beyond the book, whereas the untextured-book group neither learned nor generalized (Figure 2). A marginally significant trend suggested that the textured-book group scored higher than the untextured-book group on one measure of interest during book-sharing (Active Participation, such as touching the book) but not two other measures (Affect and Availability).

Study 2's preliminary analyses suggest that compared to the untextured-book groups, the textured-book groups learned and generalized more (according to both infant behavior and parent report), and were more interested during book-sharing (according to parent report). This pattern of texture benefitting learning contrasts the pattern of texture hindering learning in Study 1. Additional findings suggest that the photo-book groups did not appear to learn more than the drawing-book groups and that parent report indicated more learning than infants' behavior did, across book groups.

Conclusions

These studies suggest that a book's tactile features may help infants learn words in the long run but not on the first reading. They also highlight the importance of researching infants' word learning from picture books more naturalistically. Results will have implications for understanding early symbolic development, and for parents and practitioners working with infants.

O.01.06 - How well do children remember fast-mapped words? A pre-registered meta-analysis of retention following the mutual exclusivity response

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Details

There is widespread evidence that young children display a mutual exclusivity response upon encountering new words (e.g., Markman, 1989, 1990). Children displaying this behaviour will select a novel, name-unknown object in response to a novel label, rather than a familiar, name-known object. The mutual exclusivity response has been viewed as a means of fast-mapping vocabulary – enabling the retention of new words with minimal and incidental exposure (Carey & Bartlett, 1978). Thus, it may play an important role in driving early vocabulary growth. Yet, while mutual exclusivity may guide the correct choice of a novel word's referent at two years of age, it does not necessarily result in retention, for even brief durations (Horst & Samuelson, 2008; Bion et al., 2013). Retention may be sensitive to various properties of the word learning task, such as familiar distractor salience (Pomper & Saffran, 2019), lexical strength (Kucker, McMurray, & Samuselson, 2020) and repetition (Axelsson & Horst, 2014). A recent meta-analysis found robust evidence for the mutual exclusivity response (Lewis et al., 2020) but

did not examine retention, which is the goal of the present study.

In a pre-registered meta-analysis we examine the evidence for retention of novel object label mappings disambiguated through the mutual exclusivity response, focusing on typically developing children aged 1-5 years. Our accepted Stage 1 report pre-registration and associated project materials are available at osf.io/gx7rf, with data collection near completion. We outline a set of hypotheses, which includes age and vocabulary as intercorrelated predictors of retention, task factors such as number of distractors and labelling episodes, and multilingualism. To accommodate both preferential looking and object selection studies, retention is operationalised as a comparison of proportion target looking or proportion target selection against chance following labelling during retention trials. Our analysis strategy is to use a nested random-effects model to estimate effect sizes, looking at both the mutual exclusivity response (following Lewis et al., 2020) and subsequent retention. We will adjust for publication bias using robust Bayesian model-averaging, along with examining statistical power of existing studies. This meta-analysis aims not only to provide clarity on the factors influencing retention following the mutual exclusivity response but also to identify areas necessitating further research.

O.01.07 - Characterising early number word learning across languages and cultures

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Details

The acquisition of number words is an early and central building block for children's later maths development. Infants often begin learning number words in the context of the count sequence before they understand the meaning of those number words. Previous research has demonstrated that language plays a crucial role in how number words are acquired and used. Certain aspects of language, such as cross-linguistic differences in grammatical morphology and syntactic cues, may influence how quickly children learn number words. The development of number words is also likely to be related to the frequency of number word input across languages and cultures (the frequency in which infants hear number words in the home). By leveraging publicly-accessible data from a large open database, we examined the developmental trajectories of number word learning across languages/cultures, and whether the frequency of input was related to the age at which infants produce these number words. We specifically aimed to: 1) characterize when infants begin producing number words "one" "two" and "three"; 2) examine whether the age at which infants learn number words varies across languages/cultures; and 3) determine the strength of the relationship between the age at which infants learn number words and the frequency of language input. Using data from the Communicative Development Inventories hosted on Wordbank (Frank et al 2016), we tested whether the developmental trajectories of infants' number word learning varied across 11 different languages (Cantonese, Greek, Hungarian, Korean, Mandarin, Persian, Portuguese, Russian, Spanish, Turkish, Swedish) in around 11,000 infants between 12-36 months of age. We specifically examined differences in when parents reported their infants first produced the words "one", "two" and "three". Characterising the slopes using generalised linear models, we found that the number word "one" was learned before number words "two" and "three" across languages. Further, the number word

"two" was learned before the number word "three", although the slope of learning varied greatly across languages. Second, we found that there were cross-linguistic differences in the ages at which children produced the number words "one" "two" and "three" (e.g., there was early learning in Mandarin compared to other languages). Finally, to address the third aim, we used the Child Language Data Exchange System (CHILDES) database to examine the relationship between the frequency of input of number words in each language. These data were added to the model to understand the amount of variance captured by typical input at home. Together, these findings illuminate the cross-linguistic and cross-cultural variation in children's early number word learning, offering new insights into how these crucial early numeracy skills develop worldwide. We discuss the findings in the context of how number words are taught – and talked about – across languages and cultures.

O.01.08 - Deaf infants' acquisition of ASL verbs

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Details

Compared to nouns, verbs tend to be harder for infants to acquire (1,2) although there is cross-linguistic variability in how quickly infants acquire verbs (3). Research into verb acquisition in American Sign Language (ASL) is scarce, but mixed**.** Early ASL vocabularies under-represent predicates relative to total vocabulary, but contain a greater proportion of predicates relative to early English vocabularies (4,5). It may be more difficult to leverage known verb learning heuristics (e.g., syntactic bootstrapping) because word order is not a reliable cue to transitivity, and because some verbs can be modified to indicate their arguments (6). However, iconicity has been demonstrated to enhance novel verb learning in spoken language (7), and ASL contains more iconicity than spoken languages. Infant signers might also leverage caregiver input, which contains very frequent verb use (8) and greater referential transparency for verbs (9). The current study addresses these mixed findings by examining the early vocabularies of deaf infants acquiring ASL. Specifically we ask if verbs are more difficult to learn in ASL relative to English, as well as the role of age, iconicity, and verb type, on acquisition of ASL verbs.

Vocabulary data was acquired via WordBank (10) for 171 infants (8-36 months) acquiring ASL (4,5). For each infant, we calculated a proportion of verbs produced relative to total possible verbs (for comparison, we repeated this with American English WordBank data). For each verb we coded its iconicity rating (drawn from ASL-LEX; 11), as well as whether or not it is a plain verb (not modifiable for person or location agreement).

To determine if verbs are more difficult to learn in ASL than English, we constructed a linear regression predicting the proportion of known verbs in an infant's vocabulary by total vocabulary and language. Both main effects and the interaction were significant (all ps <.001); those acquiring ASL learned verbs faster as their vocabulary grew relative to English acquirers (Figure 1). We next conducted a binomial regression predicting likelihood of producing the verb from the child's age, the sign's iconicity rating and verb type. We observed that each factor independently contributed significant variation to the model (Table 1). Children were more likely to produce the verb if they were older, if the verb was more iconic, and if it was a plain verb.

In sum, verb acquisition in ASL is a challenge easily met by deaf infants. We observed a quicker verb acquisition trajectory for ASL relative to English, which suggests ASL may be more "verb-friendly." Consistent with prior work, infants produced iconic verbs earlier, which suggests they may leverage iconic cues to learn action verbs (7,12). We also found that plain verbs were more likely to be learned than indicating or spatial verbs, which may be because arguments are explicit and production is consistent across contexts. Future work using a longitudinal method is likely to shed further light on the mechanisms that support verb learning in ASL.

O.01.09 - Word learning in deaf/hard-of-hearing children: The role of object naming in synchrony with child attention during parent-child free play

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Details

Children who are deaf/hard-of-hearing (D/HH) and use cochlear implants and/or hearing aids are often delayed in vocabulary acquisition compared to typically hearing (TH) children. Some difficulty may be attributable to poorer speech perception, which affects word-form encoding. However, variability in speech perception accounts for only 20% of variance in D/HH children's language outcomes (Davidson et al., 2019). Thus, other factors must also contribute to variability in vocabulary acquisition. One study reported that during parent-child free play, parents of children who are D/HH were less likely to say the names of objects in synchrony with their child's attention to the named objects than were parents of children with TH (Chen et al., 2019). Naming synchrony has been found to facilitate novel word learning in TH children (Yu & Smith, 2012); so, it is possible that reduced naming synchrony for children who are D/HH may contribute to their delays in vocabulary acquisition.

This study investigates the relationship between naming synchrony during parent-child dyads' free play with objects and children's learning of the objects' names. The study also expands on Chen et al. (2019) by comparing dyads with D/HH children and those with TH children on the synchrony between parent object naming and multiple aspects of the interactions.

Method

Subjects. Five children with severe-to-profound hearing loss and received cochlear implants by 18 months of age; Four children moderate hearing loss and received hearing aids by 18 months of age; Nine TH children. D/HH children were 28- to 32-months-old (mean = 29.7) and TH children were 22- to 33-months-old (mean = 27.7). All parents were TH.

Procedure. Parent-child dyads played for 10 minutes with toy versions of 10 objects that toddlers are unlikely to know the names of: *whisk, radish, drill, tambourine, dolphin, sloth, cactus, melon, pliers,* and *camel.* To obtain detailed information about the interactions, four cameras were positioned around the play area and both parent and child were fitted with a head-mounted camera and eye tracker. After the play session, children were tested on their word learning using a 3-item picture-pointing task.

Analyses and Results

We conducted frame-by-frame coding of what the child and parent were looking at and holding throughout play sessions and transcribed speech to identify when the parent named each object. We calculated proportion of time gazing and/or holding named object within three seconds of onset of object naming. Generalized Linear Mixed Effect Modeling revealed several differences among the dyads in both child and parent behaviors during object naming, consistent with previous findings of less synchrony during object naming for the D/HH groups than the TH group (Figure 1). Correlation analyses revealed that our main variable of interest – synchrony of child looking at target objects during parent naming – positively correlated with performance on our assessment of word learning (Figure 2) whereas total number of naming instances did not.

Conclusion

These preliminary findings suggest parent naming of objects in synchrony with children's attention may play a greater role in D/HH children's word learning than how frequently they name the words.

O.01.10 - Effects of uncertainty on word learning in 2-year-old infants and adults

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Details

Variability modulates word learning in infants and adults. Variability in the visual context can boost and variability in the number of alternative referents or stimulus dimensions hinder infants' performance in word learning task (Quinn & Bhatt, 2010; Horst el al., 2010/2011; Quam et al., 2017). We hypothesize that these conflicting effects of variability can be accounted for by the notion of entropy of the learning situation: i.e., an information theoretic measure that provides a framework for the quantitative analysis of behavioral responses to sequences of audiovisual events (Shannon, 1948). Entropy is a measure of uncertainty, with learning situations that involve more alternative events or where events occur with equal frequency having higher entropy (i.e., higher uncertainty and lower overall predictability) than situations with fewer alternative events or situations where events occurring with unequal frequencies. While studies suggests that higher uncertainty makes learning more difficult for adults (Hick, 1952;

Hyman, 1953), the way uncertainty affects infants' word learning and how its effect plays out across the lifespan has so far not been directly tested.

We tested how the entropy of the learning context affects word learning across the lifespan with the same experimental paradigm. German-speaking adults (N=48) and 26-mo German-learning infants (N=48) participated in a familiarization-switch paradigm (Figure1). Participants in the High Entropy condition, saw three object-label pairs that occurred with the same frequency during the familiarization (x10). Participants in the Low Entropy condition, saw the same three object-label pairs with different frequencies (x5/10/15). Following the familiarization, participants were tested on: (1) Same-trials showing the three-object label pairs seen during the familiarization; (2) Switch-trials showing the auditory label of the target object-label pair with either one of the two non-target objects; and (3) Novel trials pairing the auditory label of the target object-label with a novel object. To assess whether entropy affects learning, we compared participants' performance on the target object-label pair that occurred with the same frequency in both conditions (x10). We measured participants' pupil size and infants' looking-times at test.

Cluster-based permutation tests revealed partially overlapping time-windows where adults' (Fig.2A-B) and infants' (Fig.2D-E) pupils dilated significantly more in the Novel and Switch trials than in Same trials, showing that participants learned the three words. Importantly, when seeing the target object-label pair at test, adult participants' pupils dilated significantly more in the High Entropy than in the Low Entropy condition (Fig2C). Preliminary results from infants indicate the same significant trend (Fig2F). Infants also tend to look significantly less in Same than in the Switch and Novel trials, and marginally longer in the High than in the Low Entropy condition (Fig2G-H). Our results show that learning words is not only influenced by the frequency of occurrence of single object-label pairs, but also by the predictability of the learning situation as a whole. Infants and adults appear to learn words better in situations that are more predictable, with information theoretic measures capturing differences in physiological and behavioral responses that may help to quantify the complexity of word learning tasks across the lifespan.

O.01.11 - Toddler's word learning abilities from a social robot

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Details

Over half a billion people, including children, rely on digital technologies for learning new languages. The advances in speech synthesis, AI and social robotics are likely to further increase the role of digital technologies in language learning in the coming years. Here we explore what role social robots could play in education from the earliest stages of development. While young children also anthropomorphize animals and objects more than adults do (Festerling & Siraj (2022), they can have difficulties interpreting social cues from real humans in language learning situations until their second birthday (Hollich, 2000; Meylan & Bergelson, 2022). Children's willingness to learn from simplified and highly structured audio-

visual input does raise the question whether artificial agents, such as social robots, could playfully complement language acquisition during the first years of life.

We tested German-learning toddlers (*N*=24, M_{AGE}=21.6, *Range*=15-30m) in a word-learning eye-tracking experiment with a social-humanoid robot (i.e., the digital interface of the Furhat robot) in a situation where word learning is only possible if children follow the robots' social cues. The experiment consisted of 4 trials, each trial consisting of a familiarization and a test phase (Figure1). In the familiarization phase, the robot turned its head/gazed towards one of two objects, either to the left or to the right, and labelled it (e.g., "This is a BAMI"). It then repeated the sequence to the other side of the screen labelling the other object (e.g., "This is a TILA"). The robot labeled each object twice. Children were then presented with 4 test events in each trial that showed the two objects side by side without the robot (N_{TOTAL}=16). During the test events children heard either one of the learned words (e.g., "Where is the TILA?"). The stimuli consisted of 8 objects and 8 nonce words (Figure1) and the speech stimuli were synthesized with a German female voice.

Results show that, during the familiarization, children looked faster (*β*=892.2, *SE*=198.5, *P*<.0001, Figure 2A) and longer (*β*=-765.4, *SE*=113.8, *P*<.0001, Figure 2B) to the object the robot was looking at than to the unattended object. This shows that toddlers can follow the social cues provided by the robot. At test, difference scores calculated from cumulative looking times to the correct and incorrect referents varied with children's Age (*β*=-.015, *SE*=.006, *P*=.029, Figure2C). Post-hoc tests revealed that infants older than the group average (*M*=28.7) did not show significant differences in looking times (*β*=-.044, *SE*=.058, *P*=.452), whereas children younger than the group average looked significantly longer to the correct object than to the incorrect one (*β*=.172, *SE*=.068, *P*=.021). They also looked longer to the correct object significantly more than the older children (*β*=.216, *SE*=.089, *P*=.026). Younger children, who have not fully mastered the use of social cues and tend to fail in similar tasks involving humans, may therefore benefit from the highly structured social cues provided by social robots. However, without previous exposure to such robots this willingness to learn may decrease with age.

O.01.12 - Sensorimotor properties of word learning in young children with Down Syndrome

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Details

Introduction

Early word learning often occurs through free-flowing, parent-child interaction. Head-mounted eye-tracking has been revolutionising our understanding of everyday learning in typical development. Previous research using head-mounted cameras/eye-tracking has identified specific patterns of sensorimotor behaviour that are associated with word learning in typically developing children. For instance, it has been shown that children are more likely to learn novel object names when the parent produces the label whilst the child is both looking at and holding the named object (Yu & Smith, 2012). However, these processes have not yet been explored in children with intellectual disabilities (ID). As ID is often associated with receptive language delay (Marrus & Hall, 2017), which may be responsive to

early intervention (Fidler & Nadal, 2007), understanding of these processes may be important in informing such interventions. This study is the first to use head-mounted eye-tracking with young children with ID to explore child looking and holding behaviours in relation to word learning during parent-child interaction. Down syndrome is used as a model group for ID, as it is the most common known genetic aetiology of ID (Hall, 2004).

Methods

Fifteen parent-child dyads of typically developing children (17 – 27 months), and 15 parent-child dyads of children with Down syndrome (36 – 58 months) were included. These groups were matched on general ability level, using the Mullen Scales of Early Learning (Mullen, 1995). Free-flowing, parent-child interaction was recorded while dyads engaged with a novel word-learning paradigm. Child learning of the novel labels was then measured using a forced-choice test.

Gaze, object handling, and parent speech during the interaction were coded frame-by-frame. Linear-mixed effects models were used to explore child gaze and handling behaviours during naming events: moments at which the parent named a novel object. Naming events were defined as "successful" if the child receptively identified the named object in the forced-choice test.

Results

For typically developing children, it was found that visually attending to the named object was predictive of word learning (Figure 1a; β = 35.32, SE = 13.44, z = 2.63, $p < .01$). There were no significant relationships identified between handling the named object and word learning success, but it was found that typically developing children were likely to be holding the named object during naming events (Figure 2a; β = 17.87, SE = 5.08, z = 3.52, $p < .001$). However, no significant relationships were found for children with Down syndrome for either measure (Figures 1b and 2b).

Conclusion

The finding that gaze to the named object was associated with word learning for typically developing children is consistent with previous research. Although no association was found between handling behaviour and word learning, the finding that typically developing children significantly handled the named object is also consistent with previous findings. However, it was found that these relationships did not hold for children with Down syndrome. This suggests that there are group level differences in the sensorimotor properties underlying word learning between children with Down syndrome and typically developing children. This was the first study to use head-mounted eye-tracking to explore these behaviours in children with intellectual disability, and the findings indicate that further exploration of these processes is necessary.

O.01.13 - The interplay of children's age, noun vocabulary size, and shape-biased words in the vocabulary development of Korean children

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Details

This study investigates the interplay between children's age, noun vocabulary size, and the proportion of shape-biased (SB) nouns in young Korean children. A substantial portion of young children's vocabulary comprises SB items, and shape bias plays an important role in early vocabulary development, typically emerging when children acquire approximately 50 nouns (Gershkoff-Stowe & Smith, 2004; Perry et al., 2022). In contrast, their focus on learning constraints may move beyond shape bias as they learn more words and composition changes (Bates et al., 1995). Additionally, language specificity may differentiate shape-bias development across languages. For instance, the syntactic distinction between ontological concepts is absent in Korean, and the plural suffix is not mandatory in plural semantics (Lee, 2002). Interestingly, Korean children showed decreased shape bias as they aged (Lee, 2002), indicating that language experience affects their word-learning constraints.

However, little is known about the development of SB words in Korean children. It is unclear whether the 50 noun criterion is applicable, or how the developmental trajectory appears during active vocabulary development. To answer these questions, we explored the relationship between the proportion of SB words and vocabulary scores in Korean children by considering their age (18-23 months vs. 24-36 months) and noun size (<50 vs. >50).

We examined the Korean version of the MacArthur-Bates Communicative Development Inventory (K-MB-CDI; Pae & Kwak, 2011) in 303 children (156 males, mean = 23 months, 14 days, SD = 4 months, 5 days). These children were full-term babies and exhibited no cognitive or physical developmental issues. Adapting Samuelson and Smith's (1999) approach, we identified 146 SB words from the K-MB-CDI. We ran regression analyses with bootstrapping of 10,000 replications to address the non-normal distribution of data.

A three-way interaction was examined among the proportion of SB words, age, and noun size. While there was no effect of the three-way interaction, a significantly positive effect of the proportion of SB words was found ($\beta = 50.353$, SE = 11.594, $\beta_{boost} = -50.217$, $SE_{boost} = 7.914$, 95% CI = [34.821, 65.485]). A higher proportion of SB items was linked to higher percentile scores. We also found a significant effect of noun size (<50 vs. >50)(($\beta = 92.731$, SE = 32.243, $\beta_{boost} = 93.858$, $SE_{boost} = 34.805$, 95% CI = [23.160, 159.333]). The larger the noun size, the higher the percentile score. A two-way interaction effect between the proportion of SB items and percentile scores ($\beta = -47.912$, SE = 23.954, $\beta_{boost} = -48.284$, $SE_{boost} = 9.341$, 95% CI = [-66.449, -29.675]) indicated that the impact of the proportion of SB items differed as a function of children's development.

There was a positive relationship between the proportion of SB items and percentile scores, particularly in children under 24 months of age. In contrast, the proportion stabilized when it exceeded approximately 50 nouns. For children over 24 months of age, the proportion of SB words stabilized and did not significantly impact vocabulary scores. Further study is warranted by employing a larger data pool to determine whether the plateau in the proportion of SB is accounted for by age or noun size, and its implications for vocabulary development in Korean children.

O.02: Speech perception & early communication

O.02.01 - Toddlers' understanding of pronouns and reflexives

ICIS 2024 Abstract Book

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Details

We investigated toddlers' understanding of the hierarchical syntactic configurations constraining reflexives and pronouns. Reflexives, following Principle A, must co-refer with the c-commanding antecedent within the local domain (e.g., He_i washes $himself_{i/*j}$), while pronoun reference, according to Principle B, must be disjoint from its local c-commanding antecedent (e.g., He_i washes $him_{j/*i}$). The asterisk* indicates ungrammatical co-reference with an antecedent. Previous research mainly tested older children (e.g., Chien & Wexler, 1990; McKee, 1992) and used traditional tasks (e.g., act-out, picture-identification, grammaticality judgment). One research group recently showed emerging knowledge of Principles A and C in English-learners as young as 30 months, using a preferential looking task (Lukyanenko et al. 2014, Lidz et al., 2021).

We recently tested French-learning 30-month-olds' understanding of Principles A and B using an eye-tracker (xxxxxx, 2020). Using simple sentences (similar to those in Lukyanenko et al. 2014 and Lidz et al., 2021), we showed that toddlers can correctly interpret reflexive (e.g., *il*$_i$ *se*$_{i/*j}$ *lave.* 'he$_i$-self$_{i/*j}$-wash') and object-pronoun (e.g., *il*$_j$ *le*$_{i/*j}$ *lave.* 'he$_j$ -him$_{i/*j}$-wash') referents, consistent with Principles A and B. However, using simple sentences has a serious limitation because performance can alternatively be explained by linear processing: toddlers can also succeed by assuming that reflexives must co-refer with its linearly adjacent NP and that pronouns cannot. The present study aimed at teasing apart the hierarchical versus linear-adjacency accounts.

In an eye-tracker experiment we further tested Principles A and B with French-learning 30-month-olds, using local-clause sentences with complex subject-NPs (e.g., *Le papa*$_i$ *du bébé*$_j$ *se*$_{i/*j}$ *lave.* 'the-dad$_i$-of-the-baby$_j$-self$_{i/*j}$-wash' versus *Le papa*$_i$ *du bébé*$_j$ *le*$_{j/*i}$ *lave.* 'the-dad$_i$-of-the-baby$_j$-him$_{j/*i}$-wash'). In these sentences, both antecedents were in the local clause, but only the complex NP *le papa du bébé* c-commands the reflexive/pronoun. Therefore, *le papa du bébé* (effectively *papa*), but not *bébé*, must co-refer with the reflexive. In contrast, *le papa du bébé* (effectively *papa*) cannot co-refer with the pronoun, whereas *bébé* can (since it does not c-command the pronoun). If, however, toddlers interpret that the reflexive and its linearly adjacent NP must co-refer and that the pronoun and its linearly adjacent NP cannot, they should misunderstand *bébé* as co-referring with the reflexive-*se* and as disjoint with the pronoun-*le.* As in our previous study, each trial displayed two side-by-side pictures depicting the actions of the target verb (self-directed versus other-directed, e.g., Figure 1), while a sentence (Reflexive-type or Pronoun-type) was heard. A cluster-based analysis of eye gazes revealed that toddlers' looking diverged significantly for the two trial types following the sentence offset (i.e., the grey time-window in Figure 2) (p=.035), with more looking to the other-directed actions in the Pronoun trials, and more looking to the self-directed actions in the Reflexive trials. Thus, toddlers' interpretations of the co-references of the pronoun/reflexive with the antecedents were adult-like, governed by the c-commanding conditions of Principles A and B.

Taken together, we showed that toddlers understand the binding conditions governing pronoun/reflexive interpretations, reflecting hierarchical syntactic knowledge early in acquisition. This is the first demonstration of c-commanding (which is structurally complex) in children at such a young age.

O.02.02 - Sex differences in developmental trajectories of early vocal contingency in infancy: autism spectrum vs. typical development

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Details

Previous research on early social engagement in Autism Spectrum Disorder (ASD) has identified developmental cascades in infant-caregiver vocal interaction, with differences in trajectories of vocal contingency within the first year of life influencing autism severity and language outcomes at two years. Known differences between boys and girls in ASD prevalence and in speech and language acquisition suggest that these results may differ according to sex, shedding light on potential protective factors or different pathways of disruption.

Accordingly, the goal of this study was to determine whether trajectories of early vocal contingency from 0-18 months discriminate later diagnostic outcomes at 2 years of age, in ways that differ between male and female infants, by reanalyzing our earlier findings to test for sex effects in vocal development.

As part of an NIH Autism Center of Excellence, we tracked vocal development in infant siblings with a family history of ASD and controls. Each child wore a recording device (LENA) for one day every month from 0-24 months to provide audio recordings of their vocal behavior and natural language environment. Using automatic speech recognition technology developed by our laboratory, we identified the number of vocalizations per hour for infant and caregiver, and calculated the rate of contingent interactions based on timing statistics. Using Functional Data Analysis, we determined developmental trajectories for each child and mean developmental trajectories by group, with bootstrapped functional confidence intervals; permutation tests were used to identify significant differences between groups, based on sex and diagnostic outcome. In our final sample, 44 children (29M:15F) were diagnosed with ASD, 35 with Broader Autism Phenotype (25M:10F), 12 with non-autistic developmental delays (8M:4F) and 100 (53M:47F) were typically developing, based on clinical assessments conducted at 2 and 3 years.

Consistent with our previous findings, we found significant differences ($P<.05$) in developmental profiles for vocal contingency and infant volubility within the first year, between ASD and TD groups, and between male and female infants within these groups, with mixed findings for the other groups. Male infants with ASD showed rapid declines in contingency from birth through 12 months, with declines in volubility from 6 months, whereas female infants with ASD recovered from initial deficits in contingency and volubility from birth almost to within the typical range by 12 months (Figure 1). In typical development, male and female infants had similar profiles for contingency and volubility, but these were lower overall in females than males.

Our results indicate that developmental trajectories of vocal contingency within the first year of life discriminate diagnostic outcome at two years, consistent with core deficits in autism, with significant sex differences in ASD from birth. Inflection points in infant volubility around six months across groups

potentially reflect the transition from endogenous to socially motivated vocal behaviors, when the influence of early contingency first becomes apparent. Overall, these results provide the earliest evidence for sex differences in autism, and indicate the need for early interventions targeting social interaction and vocal development from the first months of life, tailored to address these differences.

O.02.03 - The protolexicon at the end of the first year: Evidence from consonant vs. vowel processing in frequent words and part-words in French

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Details

At the end of the first year, infants' mean receptive vocabulary approximates 50 words (CDI measures for French: Kern, 2007). However, these words might be "blended together" with part-words in a protolexicon, as suggested by French-learning-11-month-olds looking similarly at frequent words (*e.g. bonjour, lapin*; hello, rabbit) and frequent part-words (*e.g. korin*, from "encore un": *one more*) (Ngon et al., 2011). As such, frequency, and not lexical status, would determine whether a portion of the speech input belongs to the protolexicon. Following this idea, the current study evaluated whether consonants and vowels are processed similarly in frequent part-words as they are in frequent words, for which recognition is more impacted by consonantal than vocalic alterations (Poltrock & Nazzi, 2015).

We ran two experiments with HPP. For both, items were selected from a toolbox for phonologizing infant-directed speech corpora automatically from CHILDES orthographic corpora transcription of speech input to French-learning infants under two years of age, considering four phonological rules, *i.e.* liaison, liquid deletion, enchaînement, and "je"-devoicing (Carbajal, Bouchon, Dupoux & Peperkamp, 2018). From the resulting phonological transcriptions, all consonant initial disyllabic words *and* part-words were ranked on their frequency of occurrence. Exp 1.'s stimuli derived from the 10 most frequent *part-words* extracted from this ranking (*e.g. korin*) into 10 consonant- (*e.g. kotin*) and 10 vowel mispronunciations (*e.g. korai*). Exp.2's stimuli derived from the 10 similarly frequent *words* extracted from this ranking (e.g. *bouton,* button) into 10 consonant- (*e.g. bousson*) and 10 vowel mispronunciations (*e.g. bouto*). Note that Exp. 1 and 2's items were 1.8 times less frequent than in Poltrock & Nazzi (2015).

Exp. 1 compared 12-month-olds' processing of consonant *vs.* vowel mispronunciations of the 10 frequent part-words. A repeated-measures ANOVA of looking times showed no effect of type of mispronunciation (***Fig. 1.A***) and a Bayesian paired-sample t-test offered moderate to strong support for H_0 (***Fig. 1.B***), suggesting that the absence of bias towards consonant or vowel mispronunciations within part-words does not emerge from infants' randomly response. This result could be due to the lack of lexicality of part-words, and/or lower frequency than in Poltrock & Nazzi, (2015) which were 1.8 more frequent than our frequent part-words.

Exp. 2 compared infants' processing of consonant *vs.* vowel mispronunciations of the 10 frequent disyllabic words. These words were familiar to 26% of 12 month-olds on average (Kern S., personal

communication), and 33% according to Wordbank. A consonant bias in Exp. 2 would attribute the absence of bias in Exp. 1 to lexical status and not frequency. A repeated-measures ANOVA showed no effect of type of mispronunciation (***Fig. 2.A***) and a Bayesian paired-sample t-test offered moderate to strong support for H_0 (***Fig. 2.B***). Therefore, consonants and vowels are processed equally within less frequent words. Together, the two experiments suggest that small changes in frequency might prevent words from entering infant's protolexicon and/or the display of the consonant bias at this age. How lexical status might interact with frequency for the emergence of the consonant bias remains to be understood.

O.02.04 - Phonetic discrimination in Tagalog-learning infants: Testing the influence of acoustic salience

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Details

Studies suggest that in the first six months of their life, infants initially show universal discrimination abilities of both phonetic differences that are contrastive and non-contrastive in their native languages (Kuhl, 2004; Tsuji & Cristia, 2014). Notably, this narrative is heavily based on studies of infants learning Indo-European languages. This sample bias is problematic for the generalizability of acquisition theories, making the diversification of our research essential (Kidd & Garcia, 2022; Singh et al., 2023). Regarding the universal discrimination account, studies on Asian languages crucially show only later discrimination even of native contrasts (e.g., Mazuka et al., 2022). Moreover, it has also been proposed that infants' discrimination depends on the acoustic salience of the contrast (Chládková & Paillereau, 2020). Narayan et al. (2010), for example, found that 4-month-old English-learning infants cannot discriminate the subtle /na/ and /ŋa/ contrast but only the more salient /ma/ and /na/—at an age at which universal discrimination is usually found. They also found that infants in Canada learning Tagalog, an understudied Austronesian language, showed discrimination of the native /na/ and /ŋa/ contrast only at 10-12 months. However, Sundara et al. (2018), using an infant-controlled paradigm, showed countervailing evidence that English-learning infants can discriminate /na/ and /ŋa/ at age 4 and 6 months. Currently, evidence that will complete the picture, namely from infants growing up in Asia with this contrast in their language, is still missing.

In this pre-registered study (OSF: https://osf.io/82v49), we test the discrimination abilities of Tagalog-learning 4- to 6-month-olds in the Philippines using Sundara et al.'s (2018) procedure. To our knowledge, this is the first infant perception study in the country. Under the perceptual salience account, Tagalog-learning 4- to 6-month-olds would have more difficulties discriminating the subtle /n/ and /ŋ/ contrast compared to the more salient /n/ and /m/ contrast. Under the universal discrimination account, they would show discrimination of all contrasts.

The experiment focuses on infants' discrimination of the subtle /na/ and /ŋa/ contrast. Based on power analysis results, we will test 20 4- to 6-month-olds. We will use a central fixation paradigm with a habituation (/na/ or /ŋa/) and a test phase consisting of 1 switch and 1 non-switch trials (counterbalanced order), and 1 final /ma/ trial. The audio stimuli are from Narayan et al. (2010). Independent variables are the habituation stimulus and the test trials. The dependent variable is the accumulated looking time for the test trials. Discrimination is indicated by longer looking times for

switch compared to non-switch trials. We will collect this data during fieldwork this December 2023, so the analysis will be finished before the conference.

This study informs on the influence of acoustic salience on perception abilities. Additionally, it contributes to increasing the diversity of our science, especially given differing results in terms of perceptual narrowing in Asian languages.

O.02.05 - Mothers' estimations of their infants' word comprehension: effects on mothers' verbal input and infants' receptive vocabulary

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Details

Infants' language skills are often evaluated via indirect measurement tools like parent reports (i.e., Communicative Development Inventory; CDI). Studies using indirect measures showed that infants' language skills are related to the mother's verbal input (Cartmill et al., 2013). Only a few studies have examined how these indirect measures reflect infants' actual language skills. For instance, infants correctly looked at the target pictures in the preferential-looking paradigm both for the words that mothers reported to be comprehended and for the ones that were reported as not yet comprehended (Houston-Price et al., 2007). However, less is known regarding the effect of mothers' estimations of their children's language knowledge on their own verbal input to their infants. This study examines mothers' estimations regarding their infants' word comprehension, especially across diverse SES backgrounds, and how these estimations affect maternal verbal input and infants' receptive vocabulary skills.

We examined 34 Turkish-speaking mother-infant dyads from diverse SES backgrounds (i.e., maternal years of education) when the infants were 14 months old. Infants' receptive vocabulary skills were assessed via Turkish CDI (Aksu-Koç et al., 2019) as an indirect measurement and the Looking While Listening (Fernald et al., 2008; LWL) task as a direct measurement with an eye-tracker. In the LWL task, infants were presented with eight trials with one distractor and one target object while exposed to the target object's label. We coded looking time at the target and distractor objects. If infants looked at the target object longer than the distractor object, we coded the word as comprehended; otherwise, we coded it as non-comprehended. Then, we calculated mothers' under- and overestimation by comparing maternal reports and infants' LWL performances for these eight words. Underestimation refers to the mother's reporting as "does not comprehend" the related word, although the infant looks longer at the *target* object. Overestimation refers to the mother's reporting as "comprehends" the related word, although the infant looks longer at the *distractor* object. We calculated the proportion of overestimation and underestimation with respect to the total of eight words. Lastly, mother-infant dyads participated in free play sessions for 5 minutes to assess the quality (i.e., linguistic complexity) and quantity (i.e., total number of words and total clauses) of maternal input.

We found no association between mothers' years of education and different types of estimations and verbal input quantity and quality (*p*s>.05). Furthermore, while mothers' overestimations were positively associated with their total number of words (β=.458, *p*=.015), underestimations were negatively associated with their inputs' linguistic complexity (β=-.564, *p*=.007). Lastly, mothers' verbal input quality and quantity were not associated with infants' receptive vocabulary scores.

Our findings corroborate the existing evidence that mothers, regardless of their SES backgrounds, might estimate their infants' word comprehension differently than their infants' performance in a more direct measurement (e.g., Bennets et al., 2016). Moreover, mothers' input appears attuned to their estimations of their infants' language capabilities, which might not align with infants' true performances. We found no association between the amount and quality of maternal input and infants' receptive vocabulary. This also means that other factors, like infants' understanding of sociopragmatic cues, need to be looked into as well.

O.02.06 - Perceptual sensitivity in the visual modality: Deaf and hearing infants distinguish unknown signed languages but attend to different features

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Details

This study explores how deaf and hearing infants perceive visual languages, and how early experience shapes perceptual development. Previous spoken language research indicates that infants are highly sensitive to natural language patterns and preferentially attend to linguistically structured information in their environment (Kuhl, 2007). As babies gain experience, they attune to patterns in their primary language and lose the broad sensitivity of early infancy (Werker & Hensch, 2015).

Only a few studies have tested perception of signed language stimuli (e.g. Krentz & Corina, 2008; Nácar et al., 2017; Stone et al., 2017), but they indicate that young sign-naive infants recognize signed input as language. Deaf infants have rarely been included in these studies so little is known about their linguistic perceptual development. In this study, I focus on determining if deaf and hearing infants recognize the difference between unknown signed languages, and identifying what linguistic features may drive attention.

I designed and ran a novel online preferential looking paradigm (PLP) with deaf (n=14) and hearing (n=29) infants ages 5-18 months. Infants watched videos that simultaneously presented two different language samples. Looking time (LT) was analyzed for evidence of discrimination and preference. One run showed Russian Sign Language (RSL) and German Sign Language (DGS), testing infants' abilities to recognize unknown languages as distinct. The second showed American Sign Language (ASL) and an invented manual code for English (Signing Exact English/SEE), examining preferences for natural language versus an invented system. Linguistic analysis showed differences in prosodic patterns and sublexical structures (Figure 1), including significant variation in type and frequency of mouth movements. The natural languages patterned differently across the analyzed features but were within similar ranges; the invented system was quite distinct.

Deaf and hearing infants showed a robust ability to discriminate between both sets of videos. Most of the babies attended more to the natural language (ASL) than the invented system (SEE). Taken together, these results support the important finding that sign languages are perceived and processed as linguistic information by infants regardless of their language or sensory experience. Between-group differences point to some potential effects of early experience on infant preferences (Figure 2). For example, in RSL/DGS, the hearing infants were drawn to DGS, which displays more facial affect and more mouthing than RSL. Deaf infants did not show a strong bias towards either language, despite the potentially less engaging facial behavior of RSL. Similarly, SEE, which includes complete English mouthing, was predominantly preferred by hearing infants while ASL was more appealing to almost all of the deaf infants. These results suggest that while mouthing is compelling to hearing infants, deaf infants may weigh other prosodic cues more heavily.
This study represents one of the first attempts to use signed language looking paradigms with deaf infants. The novel remote methodology successfully elicited meaningful responses, and the results indicate that deaf infants follow similar developmental trajectories as hearing infants. The looking behavior analysis indicates that deaf and hearing infants are highly sensitive to the formational aspects of signed languages, and that attention to specific features may be shaped by early experience.

O.02.07 - Play sessions lead to successful word recognition in 5-month-old infants

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Details

A major milestone in infant language development is their first words. But even before producing words, infants must begin to comprehend words. Behavioural evidence indicates that infants as young as 6 months comprehend highly frequent words in their environment, such as 'mummy' and 'daddy' (Tincoff & Jusczyk, 1999). When presented with a pair of images, 6-month-old infants look longer and more frequently to the labelled object if the competitor object is semantically unrelated, but not if it is semantically related (Bergelson & Swingley, 2012). Moreover, infants recognise word-object associations better (longer looking) if the objects are present in their home environment than if they are not (Bergelson & Aslin, 2017).

Word recognition has also been examined with neurophysiological measures like electroencephalography (EEG). In adults, the N400 is an event-related potential (ERP) that reflects lexical and semantic processing of words (Kutas & Federmeier, 2000). In infants, the N400 is first observed at around 6 months (Friedrich & Friederici, 2011). Most previous studies used screens along with spoken words presented over loudspeakers to train infants on word-object pairings. However, this approach deviates from the real-world situations in which infants usually encounter words and their referent objects: live social interactions in which the objects are introduced with naming.

Our study therefore employed a more naturalistic approach to train infants on five word-object pairs. Mothers of 30 English-learning infants were given five objects (sheep, shirt, shark, chook, shoes) and encouraged to interact with their infants, using the object names as frequently as possible, in laboratory sessions at 3, 3.5 and 4 months. Each training session lasted around 5-8 minutes and the names of the

objects were produced at least ten times per session. At 5 months infants were tested on their recognition of the five words in an ERP study in which 100 trials of congruent object-word pairings and 100 trials of incongruent object-word pairings were presented. Pairs were pseudo-randomized to avoid consecutive presentations of the same object.

A cluster-based permutation test revealed an ERP difference between congruent and incongruent word-object pairs ($p < 0.05$), with incongruent pairs showing a more negative ERP response than congruent pairs starting from around 350 ms after word onset (see Figure 1). The results suggest that infants can recognise words at 5 months, as revealed by an N400 component for incongruent object-word pairs, after a brief interactive sessions with their mothers at the three earlier ages. The results from our study highlight that infants well under 6 months of age can learn word-object associations in the context of repeated live social interactions with their mothers.

O.02.08 - Impact of the onset of prelinguistic milestones on infants' sleep

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Details

Studies on the relation between sleep and motor development in infancy have taken a bi-directional approach. Infants who napped between learning and test learned to solve a novel locomotor problem more efficiently than those who did not nap (Berger & Scher, 2017) and quality of night sleep predicted efficiency of learning a novel motor task the next day (Horger et al., 2021). Reciprocally, the onset of new motor skills, like crawling, cruising, or walking, disrupts infants' sleep (Atun-Einy & Scher, 2016; Berger & Moore, 2021; Scher & Cohen, 2015). In contrast, research on the relation between sleep and language development has been unidirectional, emphasizing the impact of sleep on learning. For example, infants learned an abstract language rule (Gomez et al., 2006), improved their vocabulary (Horváth & Plunkett, 2016), and generalized beyond specific word meanings to broader categories (Friedrich et al., 2015) if they took a nap between learning and test, but not if they stayed awake during the delay. The primary aim of this study was to examine whether the onset of key prelinguistic milestones impacts infants' sleep. Whether language and motor development have similar relationships with infants' sleep, would imply broader function of sleep on the consolidation of new information.

To document skill onset, parents (N=37)responded to a daily prompt ($M_{ParticipationLength}$=3.05 weeks) via an app asking whether they observed their infant perform a set of skills that day. For the purposes of this abstract, we focus on cooing (N= 24, $M_{OnsetAge}$ =0.98 months) and babbling (N=37 , $M_{OnsetAge}$ = 1.30 months). To document infants' sleep, a Nanit home video baby monitor infra-red light camera mounted over the crib. Users defined the area of the crib in the app so that Nanit's computer vision algorithm coded for *sleep time* (in hours) based on activity level in each pixel of the crib video over the course of the night.

Changepoint analyses tested whether infants' total nightly sleep was disrupted on or near nights of cooing and babbling onset. We calculated within-subject means of *sleep time* over 28 nights on which there was no milestone onset (14 nights on either side of onset) and the deviation for nightly sleep time on each night compared to the within-subject mean. Changepoint analysis calculated significant changes in these deviations to identify changes within infants' nightly sleep metrics compared to the within-subject mean. For babbling and cooing, sleep after onset was not affected (Figures 1 & 2). However, significant changes in deviations were present 8 days and 4 days prior to babbling onset (Figure 1). Because of this deviation, infants experienced fewer hours of sleep in the days leading up to babbling onset.

Akin to previous studies showing that the onset of locomotor skills temporarily disrupts infants' sleep, we demonstrate here that the onset of babbling seems to follow the same pattern. This finding provides converging evidence to the premise that language development is embodied and stems from changes to the motor system (Iverson, 2010), as well as to the broader idea that sleep is crucial for the consolidation of new motor expertise.

O.02.09 - Probing early morphological decomposition: the role of distributional and phonotactic cues

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Details

Introduction: Recent research (Kim & Sundara, 2021) has shown that 6-month-olds relate novel words suffixed with *-s* like *babs* and *teeps*, with just the stem *bab* and *teep*, demonstrating an early sensitivity to morphological relatedness. As infants are discovering morphology, they are also becoming sensitive to the phonotactics of their native languages (for a meta-analysis, see Sundara et al., 2022). In two experiments using the Headturn Preference Procedure (Jusczyk & Aslin, 1995), we evaluated how monolingual English-learning 6-month-olds weight distributional cues from sentence frames versus phonotactic cues in the suffixed sequences to detect morphological relatedness. In Experiment 1, distributional and phonotactic cues consistently signaled morpheme boundaries, whereas in Experiment 2, they conflicted - distributional cues signaled morphemes boundaries, however phonotactic cues were not consistent with a boundary.

In **Experiment 1**, monolingual English-learning 6-month-olds (*n* = 30) were familiarized with 2 of 4 suffixed nonce verbs embedded in passages (e.g. *babs* & *kells*) till they accumulated 45s of listening time to each. All nonce verbs were in common verb frames preceded by mommy/mama - a highly frequent word which has been shown to assist in segmentation of adjacent words (Bortfeld et al., 2005). Then in the test phase, they were presented with all 4 bare stems (*bab*, *kell*, *dop* and *teep*) in infant-controlled trials. If infants decompose the suffixed nonce verbs, then two stems (*bab* and *kell*) are expected to be familiar. Significantly different listening times to the potentially-familiar stems compared to the novel stems was used as evidence of morphological decomposition. Analysis using linear mixed effects models confirmed that infants listened longer to novel compared to familiar verb stems (Figure 1) demonstrating that they

can decompose verb+z sequences at 6-months when provided with distributional cues. Note that sequences like [bæbz] and [kɛlz] are phonotactically illegal in English, except when -z is a morpheme.

In **Experiment 2**, monolingual English-learning 6-month-olds (*n* = 19; target 30) were familiarized with 2 of 4 nonce verbs (e.g. *gihz* & *dehz*) embedded in passages, using the same verb frames as in Experiment 1. They then heard all 4 stems (*gih, deh, tuh,* and *baeh*). Without the final [z], these stems are phonotactically ill-formed because English words cannot end in lax vowels. As in Experiment 1, significantly different listening times to the potentially-familiar stems (e.g., *gih* and *deh*) would indicate morphological decomposition. Preliminary results show that 6-month-olds fail to decompose novel verbs when the resulting stem would be phonotactically illegal, despite distributional evidence for the morpheme -z.

In conclusion, distributional cues alone are not sufficient - phonotactic cues are necessary for English-learning 6-month-olds to decompose complex words into morphemes. We will discuss the implications of our findings for infants' emerging sensitivity to phonotactics and its interaction with developing morphology.

O.02.10 - Refining infant word recognition analysis through optimized gaze feature selection based on random forest

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Details

Infant eye-tracking studies have become increasingly important for understanding cognitive and linguistic development in early childhood. By tracking infants' gaze patterns, studies could infer their comprehension and processing of visual and auditory stimuli. Despite that, infant eye-tracking methodologies face significant challenges, including the infants' fluctuating attention spans, tendencies to bias towards certain stimuli, data noise and the inherent difficulty in interpreting subtle gaze behaviours.

In response to the challenges inherent in infant eye-tracking studies, we employed Random Forest (RF) algorithm to refine the analysis of infant gaze data. RF is an ensemble learning method. It operates by creating a multitude of decision trees during the training phase, each constructed on a different subset of the features. By aggregating the predictions from each individual tree, overall predictive accuracy is improved and significantly reduces the risk of overfitting. This ensemble method is particularly suited for eye-tracking data, as it can handle high-dimensional spaces and complex, non-linear relationships between features. We analyzed a variety of gaze features focusing on both the raw and adjusted proportions of gaze directed toward the target during specific test windows. The analysis includes assessing the gaze proportion towards the target upon sound stimulus and in successive one-second intervals following the stimulus (the first 400ms of gaze data is excluded). Additionally, it involves calculating the differences in gaze proportions towards the target by comparing each post-stimulus interval with the pre-stimulus baseline.

We validated the model's performance through a Leave-One-Out (LOO) process, a method particularly suited to a limited dataset. It was trained using a dataset derived from eye-tracking tests on 25 Korean infants, approximately 14 months old, and achieved an accuracy of 88.45%, significantly surpassing traditional linear regression models in internal validations. Further evaluations indicate that a specific range of 4 to 5 gaze features is optimal for predicting infant word recognition, with a plateau in correlation scores indicating that additional features do not improve correlation (Figure 1). The RF algorithm demonstrated a notable improvement in correlation with parental reports on the MacArthur-Bates Communicative Development Inventories (M-B CDI) from rule-based approach (r's between .47 and .52) to reach a correlation of .65 when a specific combination of gaze features were used (see Table 1). The rule-based approach employed three key gaze metrics to evaluate infants' word recognition: 1) increased looking time to the target versus distractors, 2) changes in looking time from baseline to target presentation, and 3) a metric accounting for image bias and baseline attention.

Overall, the integration of RF into infant eye-tracking studies offers a more robust, nuanced way of interpreting complex gaze data. Future research in this area is likely to focus on expanding the datasets, training more comprehensive models and refining the feature selection process to encompass a wider array of predictive gaze behaviors.

O.02.11 - A longitudinal investigation of the acoustic properties of infant-directed speech to Norwegian 6–18-month-old infants

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Details

The acoustic expression of caregivers' speech to infants, infant-directed speech (IDS), has been suggested to engage their attention, nurture socio-emotional bonding, and promote language acquisition (Cristia, 2013; Benders, 2013; Golinkoff et al., 2015: The ManyBabies Consortium, 2020). Yet, IDS might differ across languages and cultures (Saint-Georges et al., 2013), and provide input that is not necessarily "clearer" than adult-directed speech (ADS), as debated in the field (Ludusan et al. 2021; McMurray 2013). Moreover, longitudinal studies on the acoustic properties of IDS are sparse, and so far their results are conflicting with respect to whether, and if so how, parents' IDS changes across their child's development, potentially reflecting their maturing social, cognitive, and linguistic competencies.

In the present pre-registered study, we addressed these issues by examining the longitudinal trajectory of a range of prosodic and segmental features of IDS, and compared these to ADS, in Norwegian parents of 6–18-month-old infants. Sixty-nine families participated in the study (range of maternal education: secondary school–doctoral degree). Throughout five lab visits across one year (infant age: 6, 9, 12, 15, and 18 months), the main caregiver at the time (father or mother) was recorded reading a picture book to their infant (IDS register), and to an experimenter (ADS register). The picture book was designed to

control for the linguistic content and context of recorded speech between participants, timepoints, and registers. Each of the nine Norwegian long vowels were repeated ten times, providing a more comprehensive vowel analysis as compared to the three point-vowels reported in previous research. We segmented a total of 54,954 vowels and 22,958 phrases from the speech recordings.

We fitted a set of mixed models to predict eight acoustic properties of speech based on register (IDS and ADS), and its interactions with parent (mother and father), and infants' age. Our results revealed that IDS, as compared to ADS, was overall expressed with higher pitch, wider pitch range, slower articulation rate, and longer vowels. Additionally, vowel categories had more underlying variability and were less distinctive in IDS, and vowel space expansion in IDS was only apparent in fathers. Mothers had, in contrast, more prominent differences between IDS and ADS in vowel duration, vowel variability, and vowel distinctiveness. Both pitch range and vowel space area in IDS increased with infants' age, and vowel duration slightly decreased. Pitch height, articulation rate, vowel variability, and vowel distinctiveness remained relatively stable.

Together, our results suggest that Norwegian IDS follows the same exaggerated prosodic characteristics as typically reported in the literature for other languages (Cox et al., 2020), but also corroborate findings that parents' vowel categories are more variable and less distinct in IDS than ADS. Moreover, speech directed to Norwegian infants is expressed with some acoustic features that are dynamic across development, and others that are static. Future studies should examine whether the observed trajectories of different acoustic measures impact the social, cognitive and linguistic functions of IDS.

O.03: Memory & Executive function

O.03.01 - Flashback Episodes: Influence of parental consolidation on spontaneous memories in toddlerhood

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Details

While toddlers are often not able to explicitly recall their previous experiences, they frequently show spontaneous memory retrieval – i.e., episodes that come to mind without any deliberate attempts to recall them. To date, however, little is known about the early emergence of spontaneous memories and the factors that favor their occurrences in toddlerhood. The primary aim of this study was to document age-related differences in children's spontaneous episodic memory retrieval during the transition from toddlerhood to early childhood while also examining whether memory consolidation (i.e., throughout parental reminiscing) could favor the occurrences of these memories. To test this, a new paradigm created to experimentally induced spontaneous retrieval of a previously experienced event in 28- (n=29) and 36-month-old children (n=28) was implemented. First, all children saw an event in which an accomplice hid a gift somewhere in a room. Half of the participants were then invited to reminisce about the event with

their parent. One week later, half of the children were reintroduced into the same room and spontaneous verbal and non-verbal utterances about the event were recorded. The other half of the participants were introduced into another room and asked to voluntarily recall the event using free recall, cued-recall and recognition tasks. A mixed-effect model including age (28- vs. 36 months), the retrieval condition (spontaneous vs. voluntary), and the reminiscing condition (with vs. without) as fixed factors revealed that both 28- and 36-month-old children communicated more about the event in the spontaneous than in the voluntary condition. Memory consolidation throughout parental reminiscing, on the other hand, was only found to have a positive effect on children's spontaneous retrieval. A main effect of age was also revealed, indicating that older children recalled more details about the past event than younger children, but no interactions were found between children's age and the retrieval or the reminiscing condition. Overall, our findings provide new insights regarding the early development of spontaneous episodic memories during the transition from toddlerhood to early childhood.

O.03.02 - Comparing the predictive validity and reproducibility of within and cross brain EEG connectivity indices for modelling emerging infant executive function

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Details

Executive functions (EFs) are core cognitive control skills that predict life success. These skills begin developing during the early years to allow children to sustain attention and resist distraction (inhibitory control), hold and manipulate information in mind (memory updating) and shift attention and strategies to adapt to changing demands (cognitive flexibility). EF development occurs within the context of positive social interactions and variations in the quality of parent-child interaction impact EF development. However, little is known about the intra- and interpersonal neural mechanisms (and their relative importance) in mediating influences of parent-child social interaction on early developing executive function skills. Here, we take adopt a computational machine learning approach to objectively contrast the feature importance of within and cross brain connectivity metrics on prediction of infant attention set-shifting performance (a precursor of cognitive flexibility). Importantly, we assess the reproducibility and generalisability of these neural indices by testing their predictive performance (1) within two different countries (each sampled separately) and (2) across countries (a stronger test of generalisation).

Methods:

A total of N=96 mother-infant dyads participated in this study across two countries, Brazil (N=57) and Singapore (N=39). Infants were aged, in days, 426±141.65 (SG) and 363±69.38 (BR) respectively. Infant and maternal brain activity were concurrently recorded via electroencephalography (EEG) whilst they performed an object play task to assess parental scaffolding of infant attention set-shifting. Neural connectivity metrics (wPLI) were computed using within-infant, within-mother and dyadic (mother-infant) EEG data. Identical pre-processing pipelines were used for all neural datasets (within and cross-brain).

Graph theory-based metrics were calculated using three different thresholds (10%,15%,20%) to avoid possible bias. Feature selection was performed using Mutual Information (MI) scoring to determine the best subset of "elite" neural features (pooling across within-infant, within-mother and dyadic indices) to enter into the predictive models. Two machine learning models (one linear and one non-linear) were implemented to predict infant shifting performance (2-class median split) using the elite neural indices. Model performance was evaluated using a leave-one-out cross-validation technique.

Results:

Overall, model classification performance achieved up to 86.2% accuracy within country, and 74.9% in the combined cross-country transfer scenario. Importantly, MI feature selection revealed that dyadic (mother-infant) metrics were the most important predictors of infant shifting in the cross-country transfer scenario, followed by maternal and infant brain metrics (see Fig 1A). This advantage for dyadic metrics was observed across both types of models (linear and non-linear), as well as across all three threshold values used.

Conclusion:

Our results suggest that during early life, dyadic measures of parent-infant neural connectivity may provide robust and generalisable indices for the prediction of developing cognition, particularly emerging executive function skills. This empirical validation is an important first step toward developing reliable screening tools for early assessment of EF and its disorders

O.03.03 - One-year-old infants remember a melody a week after hearing it only twice

Laura Cirelli [1], **Catherine Tan** [2], **Haley Kragness** [3]

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Details

Infant's everyday sound environments are complex, and music is present in this soundscape 9% of the time (Mendoza & Fausey, 2021). Most tunes encountered are familiar, and are particularly effective at engaging infants by capturing their attention, mitigating distress, and eliciting rhythmic movements. Less is known about how infants engage with novel music. While research on how infants learn and remember novel music is sparse, evidence suggests that after extensive exposure to a novel song over two weeks, infants impressively recognize this song 8 months later (Mehr, Song, & Spelke, 2016). However, at least by adulthood, novel melodies heard in a laboratory setting only twice are well-remembered after 10 min, 1 day, and 1 week delays. In fact, recognition improves with longer delays (Schellenberg & Habashi, 2015).

Here, we test whether 12- to 15-month-old infants also form lasting memory for a melody after brief exposure. We also explored whether attention during exposure and social preference for the singer predicts memory. At Time 1 (n = 41), over a video chat platform (Zoom), infants first watched an engaging recording of a musician singing and playing the ukulele. The first and last song of this 4-song performance included one of two possible test songs. These original compositions were matched in

rhythm, musical key, and pitches but differed in lyrics and melody. Infants then completed the social endorsement phase, during which they watched four videos showing the musical performer expressing preference for one toy and dislike for another. Located on opposing sides of the screen, the liked and disliked toys were then presented simultaneously on a still-frame display for 15 seconds. Infant attention to the musical performance and to the liked and disliked objects was coded offline. At Time 2, which occurred 5 to 10 days after Time 1, infants joined another Zoom session with a different experimenter. Of the 41 infants who participated at Time 1, 39 infants returned for Time 2. Administered over PyHab (Kominsky, 2019), the experimenter live coded participant's looking times during the familiar song and novel song (only one of which had been heard by each infant at Time 1). These songs were audio-only recordings (voice and ukulele) by the same performer at Time 1. Six trials (3 per song condition) lasted for full song duration (45 secs) or until participants looked away for 2 consecutive seconds.

At Time 2, infants listened longer to the novel test song (M = 22.63 s) than to the familiar test song (M = 18.91 s), p = .011 (See Figure 1). These results demonstrate, that like adults, memory for melody is lasting, even after only brief exposure. Attention to either test song was not significantly predicted by attention to the performance at Time 1, which was quite high (infants attended 77% of the time), or by preference for socially endorsed objects at Time 1, which was above chance levels, t(30) = 3.0, p = .005, M = 54%.

O.03.04 - A longitudinal study of the early development of visual working memory across cultures

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Details

Working memory is a core cognitive system with verbal and visual-spatial subsystems. Here, we focus on the early development of part of the visual-spatial subsystem—visual working memory (VWM). VWM plays a key role in much of visual cognition, comparing percepts that cannot be simultaneously foveated and identifying changes in the world when they occur (Luck & Vogel, 1997). VWM appears to be predictive of individual differences in cognitive performance (Fukuda et al., 2010; Cochrane et al., 2019).

VWM is an excellent target for early assessment because it can be measured by 4 months at behavioural and neural levels (Delgado Reyes et al., 2020). A common approach uses the preferential looking VWM (PL-VWM) task (Ross-Sheehy et al., 2003). Infants visually explore two displays that blink 'on' and 'off'. On one side – the 'no change' side – the same coloured squares are always presented; on the other side, one randomly-selected square changes colour after each blink. Use of this task has revealed that VWM develops dramatically between 6 and 8 months, with more gradual changes later in development. A key question, however, is whether this task assesses, not just developmental changes in VWM across groups, but also developmental changes in VWM within individuals.

Here we present results from the first large-scale, cross-cultural longitudinal study of VWM in infancy. One arm of the study was conducted with 6-month-old infants in the UK; the second arm was conducted with 6- and 9-month-old infants in India. All infants were followed one year later. Together, the

combined data set had 330 infants (91 6mo UK; 120 6mo India; 119 9mo India) with longitudinal data on 246 infants (69 UK; 177 India). At each time point, infants completed the PL-VWM task. We also measured factors including SES, maternal education, and family income.

Analyses of change preference scores (total looking to the changing side / total looking) replicated findings from prior studies, with above-chance looking at set sizes 1, 2 and 3 for older infants, but only above-chance looking at the lower set sizes for infants younger than 7 months. However, change preference scores were not stable longitudinally. Based on recent theoretical models of the PL-VWM task (Perone et al., 2011), we split trials based on where infants were looking at the onset of the first change display as task demands vary depending on whether infants' 'first look' was to the change or no-change display. Results showed that change preference scores from both 'first look change' and 'first look no-change' trials were stable longitudinally. In the UK, this was the case across the entire sample (Figure 1). In India, we found robust longitudinal stability for the 'first look no-change' scores at the low memory load for the low SES infants. We also found robust longitudinal stability for the 'first look change' scores for boys but not for girls. Thus, individual differences in VWM are stable longitudinally from infancy into the second year of life across cultures; however, individual differences in India were modulated by SES and gender.

O.03.05 - Toddlers (but not infants) with elevated autistic traits show lower executive function scores

Maryna Nosyk [1], **Alexandra Hendry** [1]

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Details

Background:

Executive Function (EF) is an umbrella term that includes higher-order cognitive functions. Extensive research with children aged 3 years and above has demonstrated an association between autistic traits and difficulties with EFs. Due to a paucity of appropriate measures of everyday EFs in infancy and toddlerhood, it is not clear whether these associations are evident prior to preschool age.

Objectives:

Using a recently-developed parent report measure of EF suitable for 9- to 36-month-olds, we aim to address the question of whether associations between autistic traits and day-to-day EF ability are evident in infancy or toddlerhood, within a sample enriched for high variation in autistic traits (infants with a family history of autism or ADHD).

Methods:

136 UK parents of 9- to 37-month-olds with a family history of autism or ADHD took part in the study. Parents reported on their child's autistic traits using the Autism Parent Screen for Infant (Bryson et al. 2006) (9- to 23-month-olds; n=85) or the Quantitative Checklist for Autism in Toddlers (Allison et al.,

2008) (24- to 35-month-olds; n=51), and on their child's executive function abilities using the Cognitive Executive Function (CEF) composite (23 items, α=.833) and Regulation scale (8 items, α=.904) of the Early Executive Questionnaire (all ages). Within each age group (i.e. infants/toddlers), linear regression was used to estimate the association between autistic traits and CEF or Regulation scores. Hypotheses were pre-registered.

Results:

After controlling for the educational level of parents, we found that for 9- to 23-month-olds, the hypothesised associations between autistic traits and CEF scores (β=.173, *p*=.114) and between autistic traits and Regulation scores (β=-.198, *p*=.068) were not significant. As hypothesised, amongst 24- to 35-month-olds there was a significant negative association between autistic traits and CEF scores (β=-.727, *p*< .001) and between autistic traits and Regulation scores (β=-.582, *p*< .001); see Figs 1 and 2.

Conclusions:

Our results indicate that children with high levels of autistic traits may struggle, relative to their peers, with executive functions from as early as toddlerhood (in cognitive and regulatory aspects of EF). These difficulties are observed in both the cognitive and regulatory aspects of executive function. Given the importance of executive functions for language development, as well as social, academic and mental health outcomes, these findings highlight the importance of providing early support in executive function development to toddlers displaying autistic traits.

Future research should consider whether executive function-autism associations may be detected even earlier than age 2 years when autistic traits are measured using trained observers rather than parent report.

O.03.06 - Development of object recognition in the visual cortex from 2 to 9 months using awake fMRI and deep learning.

Cliona O'doherty [1], **Áine Dineen** [1], **Anna Truzzi** [1], **Graham King** [1], **Keelin Harrison** [1], **Lorijn Zaadnoordijk** [1], **Enna-Louise D'arcy** [1], **Jessica White** [1], **Tamrin Holloway** [1], **Chiara Caldinelli** [1], **Anna Kravchenko** [1], **Sojo Joseph** [1], **Eleanor Molloy** [2], **Angela Byrne** [3], **Adrienne Foran** [4], **Ailbhe Tarrant** [4], **Rhodri Cusack** [1]

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Details

Object recognition and categorisation are foundational for conceptual knowledge. Although categorisation is well-studied in young cohorts, there is still debate surrounding its origin in the ventral visual cortex (VVC). Categories such as faces appear early but the success of deep neural networks (DNNs) as models for the vision suggests they are formed along a hierarchy of feature complexity. Moreover, behavioural studies show very young infants can form mental groups by perceptual features with conceptual groups emerging later. However, behavioural studies are limited as they test if an infant

is acting upon knowledge and cannot provide evidence for the absence of a capacity for such knowledge. Neuroscience and computational modelling complement behavioural measures with unique insights. It has not yet been possible to probe infant brain representations underlying categorisation at scale but with pioneering advances in awake infant fMRI [Ellis et al., 2020] we tackle these questions by collecting the largest cohort of awake, behaving infants in an fMRI study to-date and quantifying their visual representations to a variety of categories.

Infants (n=134) attended scanning at 2- and 9-months. We measured brain responses to 12 categories of objects with 3 exemplars across viewpoints. The chosen categories had varying familiarity to young infants and spanned cortical organisation principles such as animacy and real-world size. Using multivariate pattern analysis, we quantified patterns of visual responses within VVC and compared infant category organisation to adults. Representational similarity analysis with perceptual and categorical models quantified the feature complexity encoded across development. Infant brain activity was also compared to DNNs that were either untrained or trained to recognise 1000 categories of natural images. We measured the similarity to each layer of the DNN assuming that lower layers encode simpler features than later layers.

At 2-months we observed an organisation by category in ventral visual stream with significant distinctions for within versus between category representations as well as organisation by animacy. This initial representation becomes more adult-like by 9-months and anterior ventral regions were found to become more similar to adults earlier than posterior visual regions. Analogously, comparison to a DNN trained on an object recognition task showed that anterior regions become closer to adults in their correlations to later layers of a DNN encoding complex features. In contrast, infants' early visual regions are more similar to an untrained network than adults and to earlier layers in the DNN.

We demonstrated that the neural basis of categorisation is present from 2-months and that anterior ventral regions become more adult-like before posterior regions. The presence of this organisation is prior to its functional emergence in behaviour and contrary to the idea that simpler features in early visual cortex develop before complex category representations. For the first time we apply multivariate analysis methods to an innovative infant neuroimaging dataset and define similarities between the infant brain and AI models. This provides novel insight into the youngest of humans and is encouraging evidence for the promise of awake infant fMRI.

O.03.07 - Executive function and play: Authentic assessment in natural environments

Patricia Blasco [1], **Karin Lifter** [2], **Tara Rutter** [1]

[1] Oregon Health & Science University, [2] Northeastern University

Details

This session will examine components of executive function (EF) in young children's naturally occurring play behaviors. EFs include inhibition, working memory, cognitive flexibility, plan and organization, and emotional control. Two researchers observed 10-minute video recordings of five children from the Developmental Play Assessment for Practitioners (DPA-P) focused on play behaviors and coded for EFs. Children with autism, Down syndrome, developmental delays, and without delays were included

development of the DPA-P. Interrater reliability will be shared and implications for policy and practice will be discussed.

Traditionally, EFs are assessed using elicited behaviors based on established tests (e.g., the Behavior Rating Inventory of Executive Function (BRIEF-P). Although the BRIEF-P starts at 24 months, there are no multidimensional assessments of EFs for children under 24 months. Authentic assessment, in contrast, emphasizes natural contexts, which are more appropriate for very young children. Developing a method to identify and assess EFs based on naturally occurring play behaviors would be an advance over the use of traditional assessments.
A pilot study of play observations of young children (ages 8, 18, and 36 months) playing in their homes with a caregiver were coded at 5 minute interval for 30 minutes of play. The coders examined the videos for evidence of EF components during play. Interrater reliability was 88.8% across the two coders. These play observations are part of a large database of 492 children, developing with and without disabilities, from ages 8 to 60 months, which formed the basis of the (DPA-P. The five play observations were coded by the researchers for indicators of EFs including inhibition, working memory, cognitive flexibility, plan and organization, and emotional control. For example, episodes of planning and organization were identified in activities in which the children linked activities together into a play sequence (e.g., the child sees the baby doll, looks for a spoon, stirs the spoon in a cup, and then feeds the baby doll. That example also provides evidence of working memory. The children's DPA-P play profiles will be compared to the evaluation of their EF skills.
There are no standardized multidimensional assessments of young children with and without developmental delays that include EFs within the assessment procedures particularly under the age of 2 years. This presentation aims to understand how naturally occurring play activities could be evaluated for EFs, without the use of computer or iPad technologies or reliance on elicited behaviors, for infants, toddlers, and preschoolers.

EFs are an important part of early brain development that have not been directly assessed in multidimensional approaches. EFs have been studied in infants and toddlers in laboratory settings with only one type of EF typically examined. By observing children in more ecologically valid settings, we can gain deeper insights into their EF skills, paving the way for more targeted interventions and support in their growth and development. In this session, we will engage the audience through video presentations of EFs as observed in play situations. We will discuss the implications for policy and practice.

O.03.08 - Different speakers generate separate memory traces in newborns

Emma Visibelli [1], **Ana Fló** [1], **Silvia Benavides-Varela** [1]

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Details

Language development requires the storage of linguistic content. Understanding which factors determine forgetting or memory consolidation of verbal memories is crucial for understanding the principles governing speech processing and language acquisition early in life.

Benavides-Varela et al. (2011, 2012, 2017) used functional Near-Infrared Spectroscopy (fNIRS) to investigate the formation of verbal memories at birth. Newborns habituated to a 2-syllable pseudoword could recognize it after two minutes. Interestingly, recognition did not persist when neonates heard another word pronounced by the same speaker and with the same CVCV structure during the 2-min retention period (Benavides-Varela et al., 2011). However, natural language processing requires encoding different verbal content pronounced by different speakers, making it unlikely that verbal short-term memory in neonates might be limited to a single instance or word in isolation. In this study we investigate whether separated memory traces of linguistic stimuli can be generated when two acoustically different words are presented in the familiarization and in the retention interval.

We tested neonates (n=32, on average 22.8 (std=2.32, range=[19,27]) provided good data for each experimental block) in a habituation-interference-test protocol (Benavides et al., 2011, 2012, 2017, Figure-1) using one word uttered by one speakers in the habituation and another word pronounced by a different speaker during the retention interval. Pseudowords (CVCV structure) were presented using a block design with each phase (habituation, interference, test) lasting 3 minutes (5 blocks of 6 words each, ISI 0.5-1.5 s, inter-block interval 25-35 s). These words were controlled to have the same duration and intensity. A within-subject design was implemented by having two sessions separated by 9 minutes of silence: one condition in which neonates heard the same word during habituation and test and another condition with a novel word presented during the test phase. Neural cortical activity was recorded over frontal, temporal, and parietal regions using a 42-channel fNIRS system.

Results showed typical recognition response, namely higher activation for the novel word compared to the familiar word in the test ($p=2x10^{-6}$, Figure-2). This difference was presented during the second block of the test phase. Notably, in previous work using no interference or music as interference, the effect appears in the first test block (Benavides-Varela et al., 2011), while an effect in the second block over right parietal and left temporal areas, compatible with the effect we observed in the current study, was present when an interference word was presented during habituation (Benavides-Varela, 2012).

This finding reveals that neonatal verbal short-term memory of the habituation word is retained when the interference word has different acoustic features, possibly due to better differentiation of the memory traces (Benavides-Varela et al., 2011, 2012, 2017). Moreover, the findings suggest that the variability of intervening words might be beneficial for creating more robust representation of words.

O.03.09 - Longitudinal latent profiles of executive functions from infancy to 2.5 and 5 years of age: Interrelations with mother-child interaction qualities

Pauliina Juntunen [1], **Anniina Karonen** [1], **Akie Yada** [2], **Elisabeth Nordenswan** [1], **Eeva Eskola** [1], **Fiia Takio** [1], **Hetti Lahtela** [1], **Eeva-Leena Kataja** [1], **Eeva Holmberg** [3], **David J. Bridgett** [4], **Asko Tolvanen** [2], **Hasse Karlsson** [1], **Linnea Karlsson** [1], **Kirby Deater-Deckard** [5], **Riikka Korja** [3], **Saara Nolvi** [1]

[1] University of Turku, [2] University of Jyväskylä, [3] Turku University, [4] University of Nevada, [5] University of Helsinki

Details

Objective of the study

Child EFs develop rapidly in early childhood, and reportedly link with a myriad of child outcomes, including academic performance and early-onset psychiatric disorders, making it important to understand early sources of variation in EFs. There is growing body of evidence that positive parenting (e.g. emotional availability) fosters child EF development (e.g. Fay-Stammbach et al., 2014). Still, the understanding of the associations between caregiving and EF longitudinally in early childhood is lacking, and there is almost no research on the interrelations between EF and child interaction quality with the parent. Here, we utilized latent profile analysis (LPA) and a large longitudinal EF dataset from a birth cohort to examine child EF profiles from across three time points: 8 months, 2.5 years and 5 years. Furthermore, we linked mother-infant caregiving quality, also focus on child active interaction with the mother, with these EF profiles.

Methodology

The participants were N = 835 mother-child dyads from a general population sample participating in the FinnBrain Birth Cohort Study, Finland. EF was assessed at 8 months using a modified A-not-B task, at 2.5 years using the Snack Delay and Spin the Pots tasks, and at 5 years using Spin the Pots task, the Delay of Gratification task, and EF Touch Arrows, Pigs and Farmer tasks. Mother-child interaction quality was assessed at the same three time points by analyzing a video-recorded 10-minute free play situation using the Emotional Availability Scales, which allows the assessment of maternal emotional availability and child interaction qualities. LPA was conducted in Mplus program and correlates were examined using R3Step. Furthermore, latent growth curve analysis is later used to explore the intercept and slope (as well as individual time point) mother-child interaction qualities' associations with child EF profiles.

Results obtained & expected

Four-class solution of longitudinal profiles was selected: "High EF" across ages and tasks (47.3%), "Below average EF" with lower EF across ages and tasks (6.0%), and two medium performance profiles, with other characterized by poor early Spin the Pots (32.3%) and other poor performance in Go/No-Go task at 5 years (14.1%) (Figure 1). Preliminary analyses showed that higher maternal sEA at 30 months but not in other time points were associated with higher likelihood of child belonging to the high EF vs. below average EF profile (p = .005). The analyses on child interaction are being finalized.

Conclusion

We were able to identify a profile of children performing above average vs. below average starting from infancy to preschool age, even though only one task from infancy was included in the analysis. This suggest that early EF data can be used to predict later performance. Furthermore, preliminary analyses showed that maternal caregiving quality at 30 months was associated with longitudinal child EF profile, underscoring the importance of supporting early caregiving environment to foster EF.

O.03.10 - Infants' predictions of action goals – a convergent interplay between bottom-up and top-down processes

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[1] University of Potsdam

Details

Understanding other persons' action goals is an important achievement of early social-cognitive development. I argue that infants' ability to predict others' action goals results from an interplay of stimulus-driven bottom up processes and experience-driven top-down processes. Especially when the perceptual information is opaque or incomplete, infants need to tap on own experiences with performed movements and their consequences to predict (i.e., forward modeling) or evaluate (i.e., back propagation) the outcomes of others' actions.
I present an integrative review of eye-tracking data of infants between 6 and 18 months who observed simple object-directed reach-and-grasp actions performed by a human hand or a mechanical claw (i.e., familiar vs. unfamiliar agent). In additional conditions, the agent either froze upon touching the goal object or lifted the object, accompanied by a sound (i.e., no action effect vs. action effect). The measured gaze-arrival times (of infants' gaze compared to the agent at the object) revealed time-shifted but parallel developmental trajectories after the age of 6 months, at which infants' gaze was still non-predictive (even for hand-with-effect; Adam & Elsner, 2020). In particular, infants performed predictive gaze shifts at an earlier age for the human hand than the claw, and earlier with than without an observed action-effect: hand-with-effect – 7 months, hand-without-effect – 11 months, claw-with-effect – 11 months , claw-without-effect – 18 months (Adam & Elsner, 2018, 2020, 2021).
Converging methods helped us to explain these developmental trends. In particular, we developed a computational model in an interdisciplinary collaboration with computer scientists (Gumbsch et al., 2021, 2022). This Cognitive Action Prediction Model in Infants (CAPRI) models infants' gaze behavior based on an event-perception perspective (Butz et al., 2021; Zacks et al., 2007) and active inference mechanisms that attempt to minimize the uncertainty within and across subsequent events (Friston et al., 2016). From this, the theoretical model proposed here acquired the central idea that the observed reach-and-grasp events consist of an initial state (agent at a certain location, potential goal object), a dynamic phase (agent approaching the object), and a goal-state (agent at a target location; action-effect production), which may be the initial state for a subsequent action-event. Within an event, changes come with high transitional probabilities, but goal-states entail low transitional probabilities and larger prediction uncertainty, signaling boundaries between events. CAPRI modeled the developmental trends in the infant gaze data based on implementations that from 7 months, infants shift their gaze predictively towards the goal of the unfolding observed movement, because this enables to monitor the upcoming action-effects and to reduce future uncertainty.
In a theoretical model (Elsner & Adam, 2020), I argue that infants' developing ability for action-goal prediction is driven by growing abilities to process the perceptual features when observing an action (bottom-up processing) and by increasingly elaborated action-event schemata that store previously experienced relations between movements and their consequences (top-down influences). Consequently, infants increase their abilities to predict upcoming action-events and to infer underlying action-goals and intentions from others' observable behavior, with earlier emergence for familiar agents and familiar actions.

O.03.11 - Examining visual short-term memory in 5- to 12-month-old infants in a longitudinal sample

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Details

Visual short-term memory (VSTM) is a limited-capacity storage system that is essential for visually guided behavior and is correlated with IQ and other measures of broad cognitive ability in adults (Luck & Vogel, 2013). Previous studies have demonstrated changes over infancy in VSTM using *change detection* tasks (Oakes et al., 2013; Ross-Sheehy et al., 2003). In such tasks, infants see trials in which a sample array of items is briefly presented, followed by a short delay with a blank screen, and finally a test array in which one (or more) of the items may be changed. Infants' sensitivity to changes in these arrays is related to whether or not they attend to the to-be-changed item during the sample array (Beckner et al., 2020; Cantrell et al., 2019; Eschman & Ross-Sheehy, 2023; Ross-Sheehy & Eschman, 2019).

In the present study, we longitudinally assessed VSTM in a group of ninety-four 5- to 12-month-old infants using an eye-tracking change localization procedure. Infants saw trials with the following sequence: a 500-ms sample array of three or four (set sizes) colored circles, followed by a 300-ms delay array with a blank screen, and finally a 2000-ms test array in which one randomly-chosen circle has changed color color (see *Figure A*). We asked how infants' attention to an item in the sample array was related to their detection of a change in the test array.

We asked if infants successfully stored information in VSTM at both set sizes three and four when they were approximately 5.5 months of age, 8 months of age, and 12 months of age. Specifically, we calculated infants' *change localization scores* on each trial by dividing the duration of infants' looking at the changed item during the test array by their looking at all items (3 or 4 items) combined during the test array. Successful detection and localization of the changed item are indicated by above-chance change localization scores (chance =0.33 for set size 3 and 0.25 for set size 4).

Two main patterns were observed. First, as predicted, at all ages infants showed mean change localization scores that were above chance for set size 3, all *p*s < .001. In contrast, although these infants did not have change localization scores that were greater than chance at set size four on their first visit, $t(65) = 1.78$, $p = 0.08$, their scores were greater than chance for set size four on the later visits, *p*s < 0.001. Second, at all set sizes, change localization was stronger when infants looked at the to-be-changed item during the sample period. Even at 5.5 months, infants localized the change at set size 4 if they had looked at the to-be-changed item during the sample, $t(40) = 3.43$, $p = 0.001$. These results add to our growing understanding of infants' VSTM and how attention contributes to what infants store in VSTM.

O.03.12 - Measuring long-term visual recognition memory in the infant brain using frequency-tagging EEG

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Details

The ability to memorize and subsequently recognize visual inputs is a fundamental cognitive function of the human brain that emerges early in development (Pascalis & de Haan, 2003). A variety of methods have been designed to assess visual recognition memory in infants, either behaviorally or using neural measures (Reynolds, 2015; Rose et al., 2004). However, it remains difficult to define sensitive and objective markers of long-term (i.e., for days) recognition memory that could be used at any age. Here, we report a novel approach to characterize long-term visual recognition memory in 4- to 6-month-old infants using a frequency-tagging design in scalp electroencephalography (EEG). Eighteen infants were tested twice, with at least one week between appointments. At each appointment, their brain activity was recorded while they were exposed to rapid stimulation streams of 3 stimuli / sec to tag a general visual response at 3 Hz and harmonics (i.e., integer multiples) in the EEG spectrum. This response to the train of stimuli, reflecting basic visual function and indicating how much attention is paid to the stimulation, was expected at each appointment (before and after learning). Critically, stimuli were 36 natural images divided in 3 sets of 12 stimuli. Sets depicted the same 12 categories (animals and manufactured objects) with different exemplars across sets. For each infant, one set was learned between the two appointments using a book of 12 pages (1 stimulus / page) that parents had to show to their infant while reading a short story each night between the two appointments. During the experiment, this set was presented as every 3rd stimulus (at 1 Hz) within the stimulation stream (counterbalanced across infants) to tag a visual recognition response at 1 Hz and harmonics in the EEG spectrum, expected only at the second appointment (after learning). Results revealed the general visual response to the rapid 3-Hz stimulation over the middle occipital cortex at both appointments (before and after learning). This large response was slightly reduced after learning compared to before learning, indicating that infants paid less attention to the stimuli the second time they were tested. Most importantly, we found no significant response at 1 Hz and harmonics at the first appointment (before learning), confirming that the set displayed once per second had no specific status compared to the other sets. In contrast, a significant visual recognition response to the learned images was identified at the second appointment (after learning) over left occipito-temporal and parietal brain regions. This response was thus significantly larger after learning as opposed to before learning, demonstrating that infants recognized the images they were exposed to through book reading between the two appointments. Overall, we document a powerful frequency-tagging EEG approach to measure long-term visual recognition memory in the infant brain, such that characterizing memory functioning in early infancy is substantially facilitated. This approach also opens an avenue for tracking and quantifying memory development across the lifespan using the same approach at any age.

O.04: Risk factors for development

O.04.01 - Exploring characteristics of infants and toddlers supported through an expulsion prevention initiative for early care and education providers

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Details

Research has highlighted the prevalence of expulsion as a response to challenging behavior in early care and education (ECE) classrooms (Gilliam, 2005; 2006). Most studies have focused on preschool age children and less information is available on the suspension and expulsion of infants and toddlers from ECE settings, though local evaluations in U.S. cities suggest that rates among toddlers may be similar to those of preschoolers (Child Care Care State Capacity Building Center, 2017; Gerdes & Renew, 2016). This study will describe characteristics of infants and toddlers identified as at-risk for expulsion and expulsion outcomes for those receiving supports designed to reduce expulsion.

Data were gathered as part of an evaluation of 'BehaviorHelp', launched in 2016 in the state of Arkansas (in the Southern U.S.) to provide technical assistance (TA) and early childhood mental health consultation (ECMHC) to ECE providers to reduce expulsions. Data on the characteristics of referred children were gathered through structured interviews with the ECE provider. Observational data on classroom practices to support social-emotional development was gathered using a short form of the Teaching Pyramid Infant Toddler Observation Tool (TPITOS; Bigelow, Carta, Irvin & Hemmeter, 2009). Expulsion outcomes were documented on a case closure form by the TA provider or ECMH consultant who provided support services.

Of the 2,436 children referred for support based on expulsion risk, 298 (12.2%) involved children ranging in age from 0 to 2 years of age (M=1.771, SD=0.42). Most infant-toddler referrals were for male children (77.5%), who were non-Hispanic Caucasian (63.6%), non-Hispanic African American (22.8%) and multi-racial (8.5%). Just 4.4% of families were of Hispanic ethnicity. About one-third (31.7%) received developmental therapies such as speech, occupational, or physical therapy. ECE providers reported that 10.9% of the children referred were currently in foster care and 40.6% had experienced an event that may be traumatic, such as abuse and neglect, parental behavioral health concerns, parental incarceration and domestic violence. As shown in Table 1, when asked to describe the challenging behaviors that led to the referral to BehaviorHelp, teachers most commonly reported that the child 'hurts others' (88.3%) or 'has difficulty following routines' (58.7%).

BehaviorHelp cases were assigned to receive technical assistance (77.8%), ECMHC (19.4%) or other support (2.8%). Of the 271 BehaviorHelp cases that were *closed* across years, 7 children were expelled (2.6%). With BehaviorHelp support, most children (78.6%) remained in the center that initiated the referral, 5.2% were transferred to another center and 7.7% were withdrawn by the parent. The remaining children left care due to aging out or graduating the program, moving out of the area or other reasons. We will report results from the TPITOS highlighting classroom strengths and opportunities to strengthen classroom practices known to support social-emotional development. Overall, results suggest that expulsion risk for infants and toddlers maybe be linked to a combination of child risk factors (e.g. trauma and developmental delay) and need to strengthen classroom practices that support social and emotional development. With support, expulsion can frequently be prevented among children identified as at risk.

O.04.02 - Factors associated with the socio-emotional behavior of infants born during the COVID-19 pandemic

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Details

Introduction: The COVID-19 pandemic and social isolation measures have affected people's lives worldwide. Although less affected by the disease, children experienced stressful situations that may have negatively affected their social-emotional behavior. Socio-emotional behavior is the way children respond to the environment, integrating internal sensations and external circumstances. A stable and predictable environment and a secure attachment are core ingredients for a child's socio-emotional development. **Objectives:** To analyze the factors associated with socio-emotional behavior in 18-month-old infants born during the pandemic. **Methods**: It was a cross-sectional study involving 438 infants born in five Brazilian cities between April and August 2021. Mothers answered, by phone call, the Preschool Pediatric Symptoms Checklist (PPSC) and the screening questionnaire for risk factors in the family context from the Survey of Wellbeing of Young Children - SWYC (Perrin et al, 2016) and questions about children's birth conditions, sleep routines and screen use, attendance at a daycare center, impacts of the pandemic on the family and the family's sociodemographic and economic characteristics (SDE). PPSC scores $\geq$ 9 indicate suspicion of socio-emotional behavioral problems (main outcome). The explanatory variables were organized into three groups: SDE aspects (family's socioeconomic status [ABEP, 2020], maternal education, mother's marital status, family composition, and ethnicity), family context (interpartner violence, maternal depression, impacts of pandemic on the family) and children´s characteristics (gender, route of delivery, gestational age at birth, birth weight, sleep and screen time routines, stimulation activities, attendance at a daycare center). The Chi-square test was used to examine the association of the PPSC results with the explanatory variables. The initial multivariate analysis by groups of variables included those with p-values <0.20 in the bivariate analysis. Hierarchical multiple logistic regression was performed, analyzing separately each group of variables. The final regression model included variables with p-value<0.05. **Results:** Table 1 presents the characteristics of the infants and their families. Figure 1 shows the variables that made up the initial models in each group of variables in the bivariate analysis and the final regression model. The final model showed that children from families with very low purchasing power (compared to the medium-high level families: OR=2.71; CI95%=1.30-5.64; p=0.01), whose mothers were suspected of being depressed (OR=2.47; CI95%=1.36-4.49; p=0.003), those with poor sleep quality (OR=2.27; CI95%=1.09-4.74; p=0.03) and those who did not have a routine to use screens (OR=1.65; CI95%=1.06-2.58; p=0.03) had a higher risk for socio-emotional behavioral problems. **Conclusions**: Our findings suggest that the family SDE context, maternal mental health, and day-by-day children's routine are associated with a higher risk for socio-emotional behavioral problems. The pandemic has affected, directly or indirectly, all these aspects of families' lives, making it hard for children to regulate their behaviors. Health and education professionals must have a comprehensive approach to children's mental health, including attention to the family environment and supporting parents on how to provide healthy routines and habits to improve children's socio-emotional development.

O.04.03 - Examining household pesticide exposure on infant's temperament and children's psychopathology

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Details

Early exposure to household pesticides has been associated with children's developmental outcomes (e.g., motor development, psychopathology; Hernandez-Castro et al., 2021; Lee et al., 2022). Infant temperament is one of the earliest indicators of socioemotional development and a significant predictor of later psychopathology. Previous evidence suggests that temperament may be influenced by perinatal environmental differences (e.g., pollution and lead exposure; Takegatal et al., 2021). Thus, early exposure to household pesticides might influence infant's temperament, which in turn would lead to increased levels of psychopathology. However, no study to date has examined the relation between early exposure to household pesticides and temperament in relation to children's psychopathology risk. The current investigation is the first study examining the relation between early exposure to household pesticides and infants' temperament. Moreover, we examined if temperament at 12 months mediated the link between early pesticide exposure at 3 months and risk for emotional and behavioral problems at 36 months. First, we hypothesized that infants who were exposed to household pesticides early in life displayed higher negative affectivity and lower effortful control later in infancy (Hypothesis 1) as well as higher emotional and behavioral problems in childhood (Hypothesis 2). Finally, we hypothesized that temperament mediated the relation between early pesticide exposure and children's emotional and behavioral problems (Hypothesis 3).

Data came from a larger project examining prenatal environmental influences on mothers' and children's health outcomes (Bastain et al., 2019). Participants (N=576) were majority Hispanic with low SES backgrounds. Household pesticide exposure was measured using a questionnaire that assessed household pesticide use when the infant was 3 months old (Hernandez-Castro et al., 2021). Infant's temperament was measured using the Rothbart Infant Behavior Questionnaire - Revised at 12 months old (Gartstein & Rothbart, 2003). Mothers completed the Child Behavior Checklist to measure their child's behavioral and emotional problems at 36 months old (Achenbach, 200). All models included adjustment for covariates such as participant recruitment site, maternal age, maternal education, household income, infant sex, infant corrected age, housing type, and ethnicity.

Early pesticide exposure predicted higher infant negative affectivity. Negative affectivity in infancy predicted children's later internalizing and total problem scores. Results indicated that infant's temperament mediated the link between early pesticide exposure and risk for emotional and behavioral problems. We also found evidence that infant's temperament mediated the link between early pesticide exposure and risk for emotional and behavioral problems. Specifically, we observed significant indirect effects of the association between early household pesticide exposure at 3 months of age and children's internalizing and total problems at 36 months of age through negative affectivity scores at 12 months of age. However, there were no significant direct effects of early household pesticide exposure on children's psychopathology for both models. We will discuss how early household pesticide exposure may be an early risk factor to infant's temperament development, which may in turn predict higher

psychopathology. Finally, we will highlight the need for future research to examine the potential risk of specific early household pesticides on children's socioemotional development.

O.04.04 - The CAPRI-Voc clinical trial: an investigation of neural and non-neural measures for the prediction of atypical language development in infants of mothers with severe mental illness

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Details

The incidence of serious mental illness (SMI) has been increasing across most Western countries over the past two decades. As a result, at least one in six children is exposed to parental mental illness. This increases the likelihood of developmental delay, particularly for linguistic ability, with effects being more marked when the parent with SMI is the mother. Unlike children with other acknowledged factors increasing the likelihood of atypical development - such as prematurity, siblings with neurodevelopmental conditions, or intra-uterine growth restriction - these children are not offered specific monitoring or support.
Given the large numbers of exposed children, the CAPRI-Voc clinical trial was initiated to develop an early biomarker of language delay in infants of mothers with SMI, and to allow for the prioritisation of infants with the highest risk in the offer of early intervention, in a context of resource rationalisation. Data were collected at baseline (infants at 9 months, +/- 1 month) and outcome (infants at 12 months, +/- 1 month). Maternal factors, including demographics, psychological assessments, and infant health details, were recorded. Infants' neural responses to voice and non-voice stimuli were measured using functional near-infrared spectroscopy (fNIRS), with a 20-channel probe covering the temporal lobes bilaterally.
95 mother-child pairs (34 with SMI) participated, with 90 providing usable fNIRS data (28 SMI) at baseline. The primary outcome measure was verbal IQ (vIQ) at 12 months, assessed with the Bayley Scales of Infant and Toddler Development – III. Non-verbal IQ (nvIQ) was the secondary outcome measure.
Bootstrap-based independent samples t-test shows that being born to an SMI mother is related to lower vIQ at 12 months ($t(93) = -2.163$, $p = .043$), even after controlling for the potential confound of socio-economic status. At the neural level, HbO concentration over the right temporal lobe suggests that, at 9 months, children with a typical likelihood of language delay (TYP) differentiated between vocal and non-vocal stimuli more consistently than SMI children (TYP: $t(61) = 3.104$, $p = .0008$, alpha .00125; SMI: n.s.). Neural responses to voice and non-voice sounds at baseline were also related to vIQ at outcome in a subsample of 68 children with valid fNIRS and vIQ data (17 SMI), particularly in channels over the right temporal lobe.
Leave-one-out cross-validation (LOOCV) shows that the highest accuracy for a decision-tree classifier (Figure 1) for the early detection of language delay was achieved when neural factors and maternal education were considered (accuracy: 83.82%; sensitivity: 68.42%, specificity: 89.80%). Linear regression with elastic net regularisation and LOOCV suggests that the dimensional prediction of vIQ is most

accurate (adjusted R2 = .305, cross-validation RMSE: 9.13) when considering HbO concentration over right temporal sites, infant sex, and exposure to sertraline medication (Figure 2).
These predictive models may support the identification and prioritisation of the most vulnerable children in the high likelihood subsets for the offer of early intervention.

O.04.05 - Biopsychosocial predictors of infant rapid weight gain from birth to 6 months

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Details

Rapid weight gain early in life is a consistent predictor of subsequent obesity. Thus, identifying factors that contribute to infant rapid weight gain is of critical importance for intervention. In this poster, we disseminate for the first time the results from a longitudinal study testing a biopsychosocial model of early life predictors of young children's obesity. As detailed in a published protocol paper, we hypothesized that (1) a multi-domain prenatal psychobiological risk index (e.g., pregnancy complications, mental health, substance use) predicts infants' subsequent psychobiological risk (i.e., high biological, physiological and behavioral reactions to stress) which in turn predicts infant rapid weight gain; (2) the second leg of the above indirect pathway would be moderated by maternal sensitivity, such that the association between infant psychobiological risk and rapid weight gain would be weaker for infants whose mothers are highly sensitive; and (3) lower maternal sensitivity and greater use of obesogenic feeding practices would predict higher risk for rapid infant weight gain.

Pregnant people (299; 47% non-White; 42% primiparous) and their infants (49% female) participated. Mothers provided a blood sample, and their anthropometrics were measured in their third trimester, and they completed online questionnaires at each wave. Infants provided four saliva samples and a 10-minute resting heart rate sample at the 2-month visit and were measured/weighed and videotaped while interacting with their mothers at 2 and 6 months. Prenatal psychobiological risk was calculated as the sum of 14 risks (Table 1). Rather than the single planned factor representing infant psychobiological risk at 2 months, the data yielded two composites: infant biological reactivity (low resting respiratory sinus arrhythmia derived from heart rate and high cortisol area under the curve derived from saliva) and infant negative emotionality (high observer rated negative mood and maternal reported negative emotionality on the IBQR-VSF). Maternal sensitivity was rated during free play, distress eliciting tasks, and a feeding episode at both 2 and 6 months and a single composite was created reflecting high sensitivity across time and contexts. Maternal obesogenic feeding practices was the sum of 9 feeding practices known to confer risk for obesity (Table 1). Infants were classified as having rapid weight gain (1) if their weight-for-age z-score change from birth to 6 months was > 0.67 SD and as not having rapid weight gain (0) if their change was $\leq$ 0.67 SD.

Analyses were run in MPLUS with missing data handled via full information maximum likelihood. Infant birth weight and maternal education were specified as covariates (Figure 1). One hypothesized path was statistically significant. Obesogenic feeding practices were associated with greater risk for infant rapid weight gain over and above covariates and other predictors. Further, there was an indirect effect of prenatal psychobiological risk on rapid infant weight gain via greater use of obesogenic feeding

practices. Including multiple predictors of early obesity in a comprehensive model is a strength of this work. Efforts to prevent obesogenic feeding practices are likely essential in the fight against childhood obesity and such efforts can begin in the prenatal period.

O.04.06 - Visual evoked potential (VEP) mediates associations between early life stress and cognitive development

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Details

Exposure to early adverse experiences has been associated with increased developmental risk, in part from early alterations to developing neural circuitry. Visual Evoked Potential (VEP) amplitude and latency, thought to index the integrity of cortical pathways and global neural maturation, might predict later risk for neurodevelopmental or cognitive impairment (Calloway et al., 1973; Jensen et al., 2019; Torres-Espinola et al., 2018). However, associations between early life stress and VEP development, particularly within the first year of life, are not well understood. Pattern-reversal VEPs were recorded from scalp electrodes in 6, 9, and 12-month-old infants experiencing low- to mid-SES (n=68). Developmental assessments (Mullen Scales of Early Learning; MSEL) were administered when infants were 24 months of age. Caregiver reports of stress and demographic variables were collected when infants were 2 months. Participants were followed longitudinally as part of a larger project exploring associations between early adversity and development. Amplitude and latency of the first positive component of the VEP (P1) were extracted. Hierarchical linear regression was used to test whether 2-month demographic or stress variables predicted VEP amplitude or latency at any time point. Separate models were run for each time point (6, 9, and 12 months). Maternal education was entered in the first step of the models. Stress variables (recent life events questionnaire; RLEQ, perceived stress scale; PSS) were added in a second step. At 6 and 9 months, models did not explain a significant amount of variance in either P1 amplitude or latency. At 12 months, step 1 of the model (maternal education alone) did not explain a significant amount of variance in P1 amplitude, however the addition of stress variables (PSS and RLEQ) in step 2 led to significant change in R^2 (Adjusted R^2 = .173, p = .012), and an overall significant model ($F(3,38) = 3.86$, p = .017). Within step 2, PSS scores significantly and positively predicted P1 amplitude at 12 months (B = .316, p = .007). Nether maternal education nor RLEQ scores were significantly associated with P1 amplitude at 12 months. Because P1 amplitude decreases across the first year, higher amplitude may index a less mature pattern. No associations between stress or demographic measures and P1 latency were observed at any time point. Linear regression was also used to test whether P1 amplitude at 12 months predicted cognitive outcomes (Mullen Early Learning Composite; ELC) at 24 months. P1 amplitude at 12 moths negatively predicted Mullen scores at 24 months, adjusting for PSS (B = -1.893, p = .014). A mediation model demonstrated that P1 amplitude at 12 months mediated associations between caregiver reports of stress at 2-months and Mullen ELC scores at 24 months (bias corrected 95% = -2.02 to -.31, excluding zero). Results suggest one pathway by which exposure to early life stress might contribute to variation in downstream cognitive abilities in late infancy and early childhood.

O.04.07 - Perinatal maternal depression and infant self-regulation: a meta-analytic review

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Details

Self-regulation—which includes regulation of physiology, cognition, emotion, and behavior—is a critical ability supporting many domains of functioning, including academic/cognitive abilities (Best et al., 2011), emotional health (Aldao et al., 2016), and relational functioning (Fitzsimons & Finkel, 2011). Self-regulation development begins prenatally, with early-emerging, more automatic components (e.g., physiological regulation) providing a foundation for higher-order, more effortful components that emerge later in childhood (e.g., executive functioning; Blair & Ku, 2022; Cerritelli et al., 2021). Thus, exposures that undermine self-regulation development during the prenatal and infancy periods can have long-term implications for many areas of functioning. One such highly prevalent exposure that has been hypothesized to be relevant for self-regulation development is maternal perinatal depression. There are clear theoretical reasons that elevated perinatal maternal depression may undermine the development of self-regulation in infancy (e.g., through prenatal programming of stress regulation or postnatal parenting differences; Goodman et al., 2020); however, empirical support for this association has been mixed. We conducted a systematic review and meta-analysis of the association between maternal perinatal depression and a range of constructs under the conceptual umbrella of self-regulation (e.g., emotion regulation, effortful control, executive functioning) measured during the first two years of life. We also examined methodological and demographic variables that may moderate the association between perinatal depression and infant self-regulation. Our search and screening procedure (Figure 1) yielded 36 included reports, containing 132 effect sizes and 5,493 unique mother-infant dyads. Consistent with hypotheses, using a three-level random effects meta-analytic model that accounted for the interdependence of multiple effect sizes from the same study, we found a small but significant overall negative association, such that higher levels of maternal perinatal depression were associated with more infant self-regulatory difficulties (r = -.093, 95% CI = -0.15 - -0.03, p = .002). Individual and pooled effect sizes are presented in Figure 2. Heterogeneity analyses suggested substantial heterogeneity in this pooled effect. We examined multiple potential moderators of this association, including study information and sample characteristics (i.e., infant sex, infant age, sample type), maternal depression information (i.e., type of depression measure, timing of depression, whether depression scores were binary or continuous), and infant self-regulation information (i.e., self-regulation construct assessed, type of self-regulation measure, reliability of self-regulation measure). Type of self-regulation measure was the only significant moderator, with effect sizes relying on observational coding approaches showing weaker associations than those relying on questionnaires, clinician assessments, or physiological indicators (F(3, 125) = 3.72, p = .013). Overall, results indicate infants of mothers with elevated perinatal depressive symptoms are at increased risk for self-regulation difficulties. Future directions for this line of research, which has implications for targeted prevention and early intervention efforts, include applying causally informed approaches to better understand the nature of the identified association, examining specific pathways linking maternal perinatal depression and infant self-regulation, and exploring the long-term effects of self-regulatory differences occurring in the context of maternal perinatal depression.

O.04.08 - Child development during lockdown: a longitudinal study with typically developing children

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Details

The years 2020/21 were marked by the COVID-19 pandemic and the consequent lockdown. Families had to socially isolate, limiting toddlers in their interactions with others outside their homes (Benner & Mistry, 2020). The pandemic scenario in Brazil was characterized by a rapid spread of the virus associated with a high number of deaths, as well as the health and economic crises that arose as a result (Werneck & Carvalho, 2020). Unemployment levels have increased, aggravating the financial situation and generating resource limitations for millions of Brazilian families (Costa, 2020), besides a drastic increase in food insecurity levels (Xavier et al., 2021). Additionally, Brazilian schools had a prolonged period of lockdown, and the approaches to deal with this issue were very different between public and private schools (Barberia et al., 2022). Associated with the social limitations, these experiences, especially for low SES children, could lead to negative developmental outcomes (Van Lancker & Parolin, 2020; Green, 2020). This study, a preliminary part of a broader project on early childhood during the pandemic, longitudinally explored the impact on typically developing children. It assessed four developmental domains (Cognitive, Socioemotional, Expressive and Receptive Communication and Language) in association with sociodemographic and maternal mental health factors. The sample comprised 39 mothers of children, aged between 5 and 38 months old during the first data collection (first trimester of 2020) and 27 to 64 months old during the second one (first trimester of 2022). Participants filled out a sociodemographic questionnaire, the Self-report Questionnaire (SRQ-20) to detect mother's psychological distress, and the Dimensional Inventory of Child Development Assessment (IDADI), which is a parent-report tool developed and validated for the assessment of Brazilian children aged 4 to 72 months. Data, analyzed with paired *t-tests,* revealed decreased socioemotional (t = 2.689, p = .011, d = .431) and a marginally significant decline in receptive communication and language (t = 1.965, p = .057, d = .315). Upon dividing the sample by school type, only public school children exhibited declines, particularly in the cognitive domain (t = 3.995 p = .045, d = .737). Furthermore, children of mothers surpassing the SRQ-20 distress cutoff showed significant decreases in socioemotional (t = 3.583, p = .006, d = 1.133) and communication and expressive communication and language domains (t = 2.382, p = .041, d = .753). Those children of mothers with scores below the cutoff point did not significantly differ in any domain. Results underscore pandemic repercussions on child development, particularly in socioemotional domains, possibly linked to reduced in-person social interactions. Notably, a significant negative impact on cognitive development in public school children highlights heightened social inequalities in Brazil aggravated by the pandemic. Consistent with existing literature, maternal mental distress was linked to lower scores in socioemotional and communication domains, suggesting potential challenges in mother-child interactions. These findings underscore the need for interventions at the educational level and, crucially, in public policies addressing the effects of the pandemic on early childhood in Brazil.

O.04.09 - Maternal prenatal Tetrahydrocannabinol (THC) metabolites correlate with infant resting-state functional connectivity

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Details

Background: Growing evidence in preclinical and clinical models suggests that prenatal cannabis exposure is associated with changes in brain functioning and behavior. However, there is a paucity of research examining prenatal cannabis exposure and brain functioning in human infants, despite documented increases in maternal use of cannabis in pregnancy. Therefore, there is an urgent need for studies of prenatal cannabis exposure and their association with neurodevelopment during the neonatal period.

Objective: To examine whether prenatal THC metabolite levels are correlated with infant functional connectivity between regions of interest in the hippocampus, insula, and caudate. We expected that the associations between cannabis exposure and infant neural functioning would persist after controlling for prenatal maternal distress. Finally, we explored whether any of the brain functioning differences that were significantly related to cannabis were also associated with infant attention and arousal.

Methods: We recruited 42 (28 female) Black-American mother-infant dyads into an observational longitudinal study that involved prenatal assessments and a newborn fMRI scan. Maternal urine samples collected during pregnancy were assayed for 11-nor-9-carboxy-Δ9-tetrahydrocannabinol (COOH-THC) metabolites, providing a biologically verified measure of prenatal cannabis exposure. Infants completed a resting-state fMRI scan and the NICU Network Neurobehavioral Scale at approximately 1-month postpartum.

Results. Levels of maternal prenatal COOH-THC were positively associated with connectivity between the left insula and left temporoparietal junction, as well as connectivity between the left caudate and caudal anterior cingulate cortex. Prenatal COOH-THC levels were also associated with weaker connectivity between the left caudate and left precuneus, as well as weaker connectivity between the left thalamus and bilateral hippocampus. We found one significant association between infant arousal and functional connectivity between the right insula and left precuneus.

Conclusions. This preliminary study found correlations between prenatal COOH-THC levels and functional connectivity in the hippocampus, insula, caudate, and thalamus in neonates. These brain connectivity changes may be a mechanism by which prenatal cannabis exposure influences risk for offspring psychopathology. Given that Black Americans are underrepresented in neurodevelopmental research, findings from this project will add an important perspective and may inform culturally informed health recommendations regarding cannabis use during pregnancy.

O.04.10 - Hypoxic-ischemic injury in the preterm infant: Predictive risk models for autism spectrum disorder

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Details

Premature birth occurs prior to 37 weeks' gestation and affects 1 in 10 births, with rates continuing to rise each year. These infants experience unique neurodevelopmental outcomes (Hee Chung, 2020) including increased risk of autism spectrum disorder (ASD) (Crump, 2021). There is a great need to identify infants at the highest risk of ASD as early as possible to provide interventions early in life when the developing brain is maximally plastic. My project uses the convergent fields of neuroscience and neonatology to make these identifications.

One of the most common risk factors for developing a neurological disorder following premature birth is the occurrence of hypoxic - ischemic injury, or a lack of oxygen in the blood (Bhutta et al., 2022). Hypoxia necessitates aggressive ventilation techniques such as positive pressure ventilation that contribute to neural inflammation in as little as 15 minutes through a cascade of inflammatory cytokines (Chan et al., 2020) (Polglase et al., 2012). This systemic inflammatory response results in damage to the vulnerable white matter of the developing brain. The connection between white matter damage and neurodevelopmental delay was first identified in animal models when researchers used hypoxic conditions to replicate white matter injuries most often seen in prematurity. These injuries resulted in mice with social and cognitive impairments similar to those occurring with ASD. (Van Tilborg, 2017).

The present study used electroencephalography (EEG) and multiscale entropy (MSE) –a measure of brain signal variability– to identify preterm infants with decreased neural variability at rest during two conditions - social (while the baby was held) and non-social (while the baby was swaddled in a bassinet). EEG data was collected from 52 preterm babies in the University of Virginia Neonatal Intensive Care Unit. MSE analyses revealed increased mean entropy in ventilated infants as compared to their non-ventilated peers during the social resting state condition. This effect was driven by the parietal lobe - a region in which overactivity is often associated with increased severity of ASD symptoms (Brieber et al., 2007). Female infants had trending increases in mean entropy when ventilated as compared to male infants. An additional 122 babies have been collected since the computation of these results. This data will be included in the final analysis which is pre-registered on the OSF website (https://osf.io/taz94/?view_only=350ac57ac0854b8bad76412755e78314).

O.04.11 - Emotional reactivity to novelty in neurodiverse toddlers and its associations with phenotypic and anxiety measures

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Details

Introduction

Expression of emotion is a fundamental capacity present from birth, helping to ensure basic infant-environment interactions (Izard, 1978). Distress in response to novelty has been linked to later emotional difficulties such as anxiety (Kagan & Snidman, 1999), highly prevalent in children with autism (Simonoff et al., 2008). Evidence remains sparse, however, regarding the methods and context (Aksan & Kochanska, 2004) in which emotions are evaluated. Developmental researchers have utilized both interpersonal sources of novelty (i.e., strangers; Rheingold & Eckerman, 1974) and non-interpersonal stimuli (i.e., objects; Buss & Goldsmith, 1998) to study emotional reactivity. Considering the importance of emotions in social, cognitive, and behavioral development, improving our understanding of reactivity to novelty in toddlers with autism and links with behavioral characteristics has important theoretical and clinical implications.

Hypotheses

1. That facets of reactivity to novelty indexed by behavioral and physiological responses to emotion induction and parent-reported temperament scales are separable into interpersonal and non-interpersonal contexts.
2. That interpersonal and non-interpersonal distress are associated with both phenotypic characteristics and anxiety measures.

Study Population and Methods

This study included 105 age-matched three-year-olds, with autism (ASD, n=44); neurodevelopmental conditions (NDC, n=31), and typical development (TYP, n=30). Children completed brief emotion induction tasks eliciting responses to novelty in 2 interpersonal (e.g., stranger approach) and 4 non-interpersonal (e.g., mechanical object) tasks adapted from the Laboratory-Based Temperament Assessment Battery, with physiological arousal (electrodermal activity/EDA) collected simultaneously. Measured in each task, peak intensity of distress (i-Distress) responses in facial, bodily, and vocal channels was coded offline; EDA was indexed by peak EDA response during each task compared to baseline. Parents completed Fear and Shyness scales from the Children's Behavior Questionnaire (CBQ). Outcome measures included: Mullen Scales (nonverbal/verbal DQ), ADOS (autism symptom severity), and Preschool Anxiety Scale-Revised (anxiety symptoms). Principal Component Analysis (PCA) was used to reduce the reactivity (behavioral and physiological expression of emotion) and parent-reported temperament variables. Groups were compared on PCA scores using GLM. Regression analysis evaluated contributions of the PCAs to outcome measures.

Results

PCA yielded two components: Interpersonal Distress (CBQ-Shyness, i-Distress/Interpersonal tasks and EDA (in both contexts)); and Non-Interpersonal Distress (CBQ-Fear, CBQ-Shyness, i-Distress/Non-Interpersonal tasks). Planned contrasts showed that on Non-Interpersonal Distress, ASD<TYP (p<.001, d=0.86) and ASD<NDC (p=.002, d=0.70) on, but all groups were similar on Interpersonal Distress (p=0.895). In the combined sample, multiple linear regressions (see **Table 1**) indicated that higher Non-Interpersonal Distress was related to: higher nonverbal DQ (p=.002), higher verbal DQ (p<.05), lower autism severity (p<.001), and higher anxiety (PAS-R Generalized Anxiety, Specific Fears, and Total Score, ps<.001). Interpersonal Distress was marginally related to subtypes of anxiety (PAS-R Specific Fears; p=.06, Generalized Anxiety; p=.09).

Conclusions
Facets of distress reactivity across behavioral, physiological, and temperament indices reflect interpersonal and non-interpersonal contexts. Distress to novelty is related to important behavioral dimensions in neurodiverse toddlers, with many clinical implications.

O.04.12 - Infant responsiveness to maternal play bids in the context of poor nutritional health

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Details

Introduction: The significance of play in early childhood development is apparent through its promotion of socio-emotional, linguistic, and cognitive processes (Yogman et al., 2018). Interactions between parent and infant are a primary source of play during the early stages of life. Play with parents establishes a relationship foundation that furthers infants' social and environmental engagement, thereby providing enriching learning opportunities (Runcan et al., 2012). However, the developmental efficacy of these interactions may be compromised by infant nutritional deficiencies, conditions that are highly prevalent in low-income countries such as Cambodia (Whitfield et al., 2019).

The present study investigated infant responsiveness to mothers' playful bids for positive engagement in the context of a larger, randomized clinical trial (RCT) in which breastfeeding Cambodian mothers received thiamine (Vitamin B1) supplementation across the first 6 -months postpartum. Mother- infant dyads completed the newly developed Positive Engagement Task (PET) involving a graduated series of maternal engagement behaviors designed to elicit smiles and enjoyment from infants. We subsequently assessed infants' changing arousal levels throughout the PET, at 2-, 12-, and 24-weeks postpartum, and evaluated the extent to which infants' health status moderated their behavior during the PET.

Research Questions:(Q1) Will infants display systematic changes in alertness throughout the PET? (Q2) To what extent will these patterns of responsiveness change with age? And (Q3) how do infants' nutritional and overall health status moderate their responsiveness during the PET?

Method: This case study is part of a double-blinded RCT in which N=335 mothers received either 0, 1.2, 2.4, or 10mg of thiamine supplementation daily, beginning at 2-weeks postpartum. Of the 335 dyads, 214 provided analyzable data for the PET at all three time points (2, 12, and 24 weeks). Infant alertness/responsiveness to maternal bids was measured in the PET, during which mothers were asked to encourage their infants to smile and sustain a mutually positive interaction. As the task progressed, mothers were prompted to add, then remove, engagement modalities (facial expression, voice, and touch) during six 30-second epochs. Infant alertness was coded from video recordings using a modified 6-state scale adapted from the NICU Neurobehavioral Scale to record changes in infants' alertness during each epoch of the PET. Measures of infant health status included: birthweight, height-for-age

status (stunting Z-score), blood iron status (ferritin levels), and inflammation markers (alpha-1-acid glycoprotein and C-reactive protein (CRP)). All analyses controlled for thiamine intervention status.

Results: Q1: On average, infants displayed significant linear and quadratic changes in alertness as mothers added and removed engagement behaviors throughout the PET (Figure 1). Q2 : Infant alertness levels increased from 2 to 12 weeks, and infants at 12 and 24 weeks showed a more pronounced linear trend in their alertness during the PET (Figure 2). Q3 : Multilevel regression modeling is currently underway to investigate Q3, though initial regression analysis of infants at 6 months suggests that increased levels of systemic inflammation, as measured by CRP, were associated with lowered peak alertness during the PET stage at which mothers were maximally engaged with their infants.

O.05: Variation in cognition across context

O.05.01 - Infants point to satisfy the epistemic needs of their communicative partner in a cooperative theory of mind task

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Details

Recent theory of mind studies employing spontaneous response measures showed that infants expect others to act in line with their epistemic mental states. However, it remains debated whether infants can rely on mindreading to guide their non-automatic responses as well.

To test this, we designed a cooperative task in which 18-month-olds were asked to point at the target object they wanted to receive. We found that when their desired object was placed behind a distractor object infants modified their prototypical pointing to avoid mistakenly indicating the distractor to their partner. Crucially, when the objects were covered and their cooperative partner was ignorant, epistemically uncertain, or held a false belief about the target's location – as opposed to being knowledgeable about it – infants pointed at the target more often and employed appropriately modified pointing gestures to provide their partner the relevant information she was lacking.

These findings demonstrate that when responding to a verbal request in a cooperative task 18-month-old infants can take into account their communicative partner's epistemic states and when necessary provide her with relevant information through optimally informative deictic gestures. Our results indicate that infants possess an early emerging, species-unique cognitive adaptation specialized for communicative mindreading and pragmatic communication.

O.05.02 - Contextual Factors Shaping the Developing Brain: The Role of Parenting Stress and Neighborhood Collective Efficacy

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Details

Infant development reaches crucial milestones within the context of both family and community. Parents, as the primary social environment, play a pivotal role in shaping the early experiences of infants, contributing to their physical, cognitive, and socioemotional development. Concurrently, the broader community context provides a backdrop that can either support or challenge the nurturing environment established within families. Research has demonstrated that parents and communities play an important role in infant brain function and in reducing the risk of psychopathology in children by providing resources and diverse experiences that shape and enhance their development (Hanson et al., 2013; Pierce et al., 2019; St. John et al., 2017; Troller-Renfree et al., 2020). Nevertheless, the role of contextual factors in infant brain development remains relatively understudied. Drawing from an ecological perspective, we aim to explore the longitudinal relations between parenting stress, neighborhood collective efficacy, and infant brain function across first 18 months of life.

Data for the Longitudinal Anxiety and Temperament Study (Pérez-Edgar et al., 2021) were collected from infants and their mothers at 4-, 8-, 12-, 18-, and 24-months of age. Due to the impact of the COVID-19 pandemic on in-person data collection, resulting in a substantial proportion of missing data at 24-months (comprising 79% of the full sample), the current study will focus on data collected at 4-, 8-, 12-, and 18-months. Parenting stress was collected using the Parent Daily Hassles Survey (PDHS-R), designed to assess the frequency and intensity of daily hassles experienced by parents (Crnic & Booth, 1991). The Neighborhood Community Survey (ICSPR) measured parents' perceptions of their neighborhood collective efficacy, reflecting the extent to which residents share values, mutual trust, connection, and a willingness to intervene for the public good. Infant brain activity was captured through resting electroencephalography (EEG), recorded continuously from 32 scalp electrodes during a four-minute baseline task at the 8, 12, and 18-month assessments.

To examine the associations between changes in parenting stress, collective efficacy, and infant brain activity in the first 18 months of life, we will employ multi-variant latent growth curve modeling. We are currently preprocessing the EEG data – EEG power spectra will be parameterized into periodic and aperiodic components (Ostlund et al., 2022). Our analyses focus on the aperiodic exponent, a non-invasive index of the excitation/inhibition balance in cortical circuits that is sensitive to environmental influences (Waschke et al., 2021). Once preprocessing is complete, we will integrate aperiodic exponent data with the parenting stress and collective efficacy data for a comprehensive analysis. Pre-registration link is as follows: https://doi.org/10.17605/OSF.IO/5VK9Y. By identifying the roles of parents and communities, the current study could deepen our understanding of how contextual factors influence infant brain development and foster a more comprehensive approach to supporting early childhood development.

O.05.03 - Emotional vocal sounds reinstated infants' recognition of other-race faces

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Details

Visual perception undergoes substantial development in the first year of life. A well-established phenomenon that indexes early perceptual development is perceptual narrowing in face recognition; infants gradually lose the ability to recognize faces of unfamiliar categories (e.g., other-race faces). While perceptual narrowing is believed to manifest reorganization in perceptual systems, recent studies showed that infants' reorganization of other-race faces could be reinstated by emotional signals. However, previous findings were limited to visual emotional information, which shared sensory modality with face identity information, therefore unable to specify the underlying mechanism. The current study used emotional vocal sounds to examine the generalizability of emotion's impact on infants' face processing.

Forty-two infants (32 White, 5 Asian, 3 South Asian, 1 Black, and 1 Middle Eastern, range: 90 - 404 days, 23 females) participated in the study. Their recognition of other-race faces was measured by a familiarization (50s) and visual paired comparison (VPC) paradigm. During the familiarization trials, infants were presented with one face on a screen, accompanied by emotional vocal sounds (10 clips, 1.5s/sound). No sound was played during the VPC phase. Face recognition was tested in 3 within-subject face learning conditions: happy, sad, and neutral vocal sounds.

We found that infants' face recognition (indexed by novelty preference) is modulated by emotional vocal sounds (Figure 1). Infants failed to recognize other-race faces when they learned the face paired with emotionally neutral vocal sounds (48%, one-sample t-test, $p = .50$). By contrast, they showed significant novelty preference in both the happy (58%) and sad (58%) conditions (one-sample t-test, Happy: $p = .009$; Sad: $p = .020$), which were also significantly higher than that in the neutral condition (paired-sample t-tests, Happy: $p = .05$; Sad: $p = .03$). Additional analyses of infants' eye movement data during face learning revealed significantly longer looking towards the eye-region across all three conditions (one-way repeated-measures ANOVA, $p = .002$, Figure 2). However, we could not conclude that emotional vocal sounds affect how infants view faces as this looking pattern was consistent across all three conditions (one-way repeated-measures ANOVA, $p = .19$). Additionally, our current results cannot be explained by differentiate face learning time as infants had similar total looking times across all three conditions (one-way repeated-measures ANOVA, $p = .610$).

Overall, our findings showed that emotional signals are integrated across modalities, specifically across the audio and visual domains. Moreover, these results also suggest that the role of emotional cues in our cognitive processes is not learned but may be innate. However, the role of emotional vocal sounds in reinstating infants' other-race face recognition is less clear. One possibility could be that infants retain some residual neural plasticity in face recognition system that is elicited by emotional signals.

O.05.04 - Time and sequence as key dimensions for joint action development

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Details

Joint action, generally defined as working together towards a common purpose, has become an important concept in many areas of cognitive science, from philosophical appraisal of its core concepts to empirical mapping of its psychological development. How the nature of action is changed by social engagements is a fundamental question for understanding the development of social cognition, our exceptional human capacity to know other minds and to share in their interest and intentions. The present work proposes a theoretical rethinking of how we conceive joint action and its development by considering the nature of human action as prospective, from the beginning of life.

Developmental research has extensively committed towards pinning down the origins of intentional engagements in joint actions and their shaping factors. Researchers have advanced strong arguments toward adopting dynamical, embodied (Fantasia, De Jaegher & Fasulo, 2014b; Lux, Gredebäck, Non & Krüger, 2022), and ecological (Adolph, 2019) theories and methods to the study of social cognitive development. Here, we draw on these arguments to provide evidence that joint action is better understood as a dynamic, situated interactional process beginning early in infancy, as forms and possibilities for participating in co-constructed sequences of shared actions (and goals) are manifold in the ecology of infants' daily social interactions.

Our work pursues three aims. First, to revisit mainstream cognitively-oriented developmental accounts of joint action as individual endeavours based on children's representational capacities (such as the ability to infer others' intentions). We discuss a few of what we see as major issues present in current developmental accounts of joint actions.

Second, to counterbalance this standard view with an embodied, dynamic and ecological approach to joint action development. We present evidence of observational studies looking at micro-dynamics of caregiver-infant activity which adopted continuous, quantitative behavioural measures to investigate how experience with formal structures of joint activities supports infants' coordinated contribution to the ongoing action, setting the stage for the complex configurations of goal-ended joint interactions.

Third, to advance time and sequence as essential elements for investigating how infants understand and share meaning with others in joint actions. This final step is achieved by attending to a fundamental aspect of action not previously considered in cognitive approaches and seldom explicitly addressed in embodied ecological accounts: the prospective quality and its necessary sequential organisation. We advance a rationale for the conceptual framework of joint action to include its temporal and sequential structures, and their intrinsic prospective qualities of human action, solitary or shared, as key analytical aspects for studying how infants understand and share meaning with another, in joint interaction.

We conclude our work by discussing how this new foundation for understanding joint action impacts the developmental science in complementary domains, requiring consideration in future research, and empirical measurement and analysis

O.05.05 - Infants' visual statistical learning abilities benefit from early exposure to the environment

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Details

Around 15 million infants are born prematurely each year. While it is well-known that these children are at risk for cognitive deficits and learning difficulties at school age (Pascal et al., 2018), only a few studies have investigated their learning capacities earlier in development, and results are mixed. Many studies have highlighted the infants' ability to extract regularities in their environment (Saffran et al., 1996; Kirkham et al., 2002). These statistical learning (SL) abilities are of primary importance since they form the basis of children's abilities to organize and form coherent representations of the external world. How the constraints linked to cerebral maturation and to the infant's experience with their environment interact with SL mechanisms remains an open question. This question can be answered by studying the differences between full-term and preterm infants.

Using an infant-controlled habituation paradigm in which three doublets of shapes were presented randomly, one shape at a time, we examined infants' ability to differentiate between sequences of shapes of high, low, and null transitional probability (TP) (see Figure 1), after habituation. We tested 27 7 to 9- and 25 10 to 12-month-old full-term infants, and 25 very preterm infants at 10 to 12-months of adjusted age. Preterms were therefore paired on postmenstrual age (i.e., the age calculated since conception) with the youngest full-terms – that is, they share the level of cerebral maturation but have more ex-utero experience, and on chronological age (i.e., the age calculated since birth) with the oldest full-terms – that is, they share the amount of experience with the external world but have less mature brains (see Figure 2).

In both the habituation and test phases, we observed an association between global looking times and post-menstrual age, with 7 to 9-month-olds and preterms looking more to the shapes than 10 to 12-month-olds. The attention devoted to visual stimuli would thus mostly depend on cerebral maturation. In the test phase, results revealed a typical developmental pattern: while 7 to 9-month-old full-terms showed a familiarity preference (i.e., they looked more at high and low than at null TPs doublets), 10 to 12-month-old full-terms showed a novelty effect. Critically, preterms likewise exhibited a novelty effect.

These findings thus demonstrate that preterms benefit from their early exposure to regularities outside the womb, and support that, at that age, visual SL abilities depend more on experience than on cerebral maturation.

O.05.06 - Examining parenting profiles and their impact on early learning outcomes

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Details

The quality of parenting that children experience during early childhood is crucial in shaping their cognitive development (Bornstein et al., 2018). Parenting quality can be determined by parents' beliefs and practices regarding childrearing (Bornstein et al., 2018). While previous research generally examined parenting beliefs and practices separately (Albanese et al., 2019), there is a growing recognition that these elements are not independent. Exploratory, person-centred approaches such as Latent Profile Analysis (LPA; Beato et al., 2016; Romm et al., 2021) offer a good way to study the interplay between parenting beliefs and practices. These methodologies identify profiles of parenting based on multiple indicators of parenting beliefs and practices and enable researchers to test relationships between these profiles, demographics and children's developmental outcomes. Despite the expanding use of such approaches, however, little is known about the parenting profiles and demographic and child outcome correlates of low-income, diverse populations.

Using a sample of families from Toronto, Canada, we empirically investigated the unique parenting profiles in a low-income sample and how these are associated with children's learning outcomes. We ask,

1. What are the latent profiles of parenting in low-income parents?

2. Are the identified latent parenting profiles related to children's learning outcomes?

Secondary data was used from a large study of 900 low-income families. A sample of 344 families completed the self-reported *Parental Cognitions and Conduct Towards Infant Scale* (PACOTIS; Boivin, 2005) and were observed using the *Responsive Interactions for Learning – Parent* (RIFL-P; Prime et al., 2015). Children's mean age was 32.79 mos (*SD* = 2.74), and 51% were male. Study families were low-income (median $40,000-$49,999 vs. Toronto's $104,378 median income; City of Toronto, 2018).

Exploratory LPA was conducted to identify and describe the latent profiles using the parenting beliefs (i.e., self-efficacy and perceived parental impact) and practices (i.e., overprotection and hostility) subscales of PACOTIS and the total RIFL-P score. Indices recommended by Muthén and Muthén (2000) and Nylund (2007) were used to statistically evaluate the model fit for the different profile solutions generated by the LPA (Table 1).

A two-profile solution with a *Low Constructive* (N=32, 9%) and a *Constructive* (N=322, 91%) profile provided the best fit for our data. Parents with a *Low Constructive* profile exhibited significantly lower responsivity ($t_{142} = -3.41$, $p < .001$), lower awareness of their influence on their child's development ($t_{352} = -24.93$, $p < .001$), and higher overprotectiveness ($t_{39.83} = 2.762$, $p < .01$) relative to parents in the *Constructive* profile (Figure 1). Parents in the *Low Constructive* profile, relative to the *Constructive* profile, had lower incomes and education levels. Lastly, children of parents in the *Constructive* profile demonstrated significantly better scores on the *Peabody Picture Vocabulary Test* (Dunn & Dunn, 2007), a measure of receptive vocabulary ($t_{168} = -2.55$, $p=0.01$).

Understanding parenting profiles for low-income families is essential for tailoring interventions that can positively impact child outcomes in these populations. Closing this research gap is crucial for fostering a more comprehensive understanding of the intricate dynamics between parenting styles, demographic factors, and children's developmental trajectories.

O.05.07 - On the move: infants' sensitivity to intention and emotion information in others' movement kinematics

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Details

The ability to perceive others' mental states is crucial for engaging successfully in social interactions (Wu et al., 2020). The way we move, our movement kinematics, reflects our intentions and emotions (Egmose & Køppe, 2018; Gross et al., 2012). Perceiving others' intentions or emotions from movement kinematics is no easy task. Adults are able to distinguish information in movement that relates to intentions and emotions in movement kinematics from other kinematic information (Cavallo et al., 2018; Roether et al., 2009), and to use it to adjust their behaviour (Quesque et al., 2016). However, the developmental trajectory of this ability in infancy is still unknown. To map it out, we conducted two studies on infants' sensitivity to intention and emotion information in movement kinematics.

In the first study, we investigated whether infants are sensitive to intention information encoded in others' movement kinematics (Figure 1). We tested a large sample (N = 147) of 14-month-olds using a habituation paradigm designed to examine whether they discriminate between grasping movements performed with different intention. Infants watched unique videos of actors grasping a bottle with one of the two intentions: to drink or to pour. Once they habituated, they were presented with two videos of grasps performed with either the same, or different, intention than before (between-subjects). We found that infants who saw movements with different intention in the first test trial looked longer towards them than infants who saw movements with the same intention. Using a novel computational approach, we show that this effect was driven by the differences encoding the intention in movement kinematics, not overall kinematic variability between videos. These results demonstrate that 14-month-old infants are specifically sensitive to the variability in others' movement kinematics that encodes intention information.

In the second study, we investigated whether infants use emotional information in others' movement kinematics to guide their object exploration (Figure 2). Twelve-month-old infants (N = 59) watched actors transporting two toys with either positive or negative emotional valence. Subsequently, the infants were given the possibility to interact with the same toys, and their manual (i.e., touching) and visual (i.e. looking) exploration of the objects was measured. We found that infants looked more towards the toy previously moved with positive emotion, compared to the toy previously moved with negative emotion, but touched both toys for the same amount of time. These findings suggest that 12-month-old infants were able to extract the emotional information from movement kinematics and link it to neutral toys, but they did not use it to inform their manual exploration of the toys.

Together, the results from both studies demonstrate that around their first year of life, infants are already sensitive to intention and emotion information in others' movement kinematics. This is particularly striking because to do so, they need to disregard a larger portion of other information

present in movement kinematics. However, they do not yet use this information to adjust their own behaviour in an adult-like manner.

O.05.08 - Neural sensitivity to mental states in infancy longitudinally predicts explicit theory of mind reasoning in childhood

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Details

Pre-verbal infants may be sensitive to others' mental states as measured by looking times (e.g., Baillargeon, Scott, & He, 2010), but they are not able to accurately answer explicit questions about them until several years later, an ability referred to as having a theory of mind. A central debate in the theory of mind literature is if, and how, these early-present implicit social-cognitive sensitivities are related to later explicit theory of mind reasoning. Here we directly address this debate by investigating the longitudinal relationship between activity of the temporal-parietal junction (TPJ, see Gweon et al., 2012) during social cognitive processing in infancy and explicit theory of mind reasoning later in childhood. Since there was no known previous work of this nature, we conducted a smaller scale, opportunistic, exploratory study to evaluate whether a larger scale studies along these lines would be warranted. Specifically, we opportunistically followed-up with participants from a previously published infant functional near-infrared spectroscopy (fNIRS) study (Mage=7.78 months; SDage=0.96 months; Hyde et al., 2018) when they were 4-6 years of age (Mage=60.88 months; SDage=7.65 months). As infants, we recorded the TPJ response to video scenarios depicting an actor with a true belief (TB) or a false belief (FB) about the location of an object hidden in an opaque box by a puppet, as well a control condition where the object was similarly placed but the box was clear allowing direct perceptual access (DP). Then, when participants were 4-6 years of age, we assessed their explicit theory of mind reasoning using the Theory of Mind Booklet Task (Richardson, Gweon, & Saxe, 2022). We pre-registered our analysis plans and predictions (https://osf.io/6bu7d) before data collection ended. Broadly, we find evidence of a longitudinal brain-behavioral link from infancy to childhood. Specifically, while we did not find that individual differences in TPJ sensitivity to the FB condition (relative to TB) was predictive of explicit theory of mind reasoning as we had predicted, we did find that individual differences in TPJ sensitivity to the DP condition (relative to TB) predicted later explicit theory of mind reasoning in childhood (β= .378-.402, p=.008-.012, see Figure 1). In hindsight, the ambiguity of whether or not to engage in belief tracking in the control DP condition, relative to the more straightforward need to track beliefs regarding the hidden object in the TB and FB conditions, may have best distinguished between infants who had different propensities to engage in belief tracking. This particular result suggests a potential role for early individual differences in active developmental experience to later theory of mind development. More broadly, these results directly link the known brain system for theory of mind in infancy with explicit theory of mind in childhood, suggesting brain and cognitive continuity for theory of mind over development.

O.05.09 - Nurturing care in rural Gambia: Qualitative perspectives from stakeholders and caregivers.

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Details

Background
The early years are widely recognised as critical in determining lifelong health and wellbeing. In 2018, the Nurturing Care Framework (NCF) was launched by WHO and UNICEF as a roadmap for families, communities, programmes, and governments to support infants and young children with the foundations for lifelong success (UNICEF, 2018). The NCF consists of five evidence-based pillars (good health, adequate nutrition, safety and security, opportunities for early learning and responsive caregiving) which are regarded as the foundations for a healthy and secure start. To support nurturing care in any given context, it is important to understand the current caregiving environment including family practices, community support, service provision and relevant policies in that context. This research was focused on the caregiving environment within the rural West Kiang (WK) region of The Gambia, West Africa, with additional insights from national stakeholders and stakeholders operating in other regions of the country.
Aims
1. To map current services and programmes in WK and more broadly in The Gambia, against the five pillars of the NCF; 2. To understand stakeholder investment in NCF in The Gambia; 3. To understand caregiver priorities for infants and young children in WK; 4. To understand barriers and facilitators to nurturing care in WK.
Methods
Six focus group discussions (FDGs) were conducted with caregivers (mothers, fathers, grandmothers) (n=36) in WK. Eleven stakeholder discussions were conducted through a combination of one-to-one interviews and FDGs. Stakeholders included health care providers and traditional birth attendants in WK, grass roots organisations and large NGOs outside of WK and national government representatives (National Nutrition Agency and Ministry of Basic and Secondary Education). Relevant existing services and programmes were mapped against the five pillars of the NCF. Inductive thematic analysis of stakeholder and caregiver insights was conducted in NVivo version14.
Results
Programmes and services pertaining to good health, adequate nutrition, safety and security were well represented both within and beyond WK, mostly within national schemes. Programmes relating to early learning opportunities and responsive caregiving were mostly provided by NGOs and small grass roots organisations, as well as one pilot government scheme, all operating outside of WK.
Caregivers in WK focused primarily on good health, adequate nutrition and safety and security for infants under 2 years. Responsive caregiving beyond physical care (e.g. verbal engagement) and early learning opportunities were viewed as more relevant to older children. The greatest facilitator for all aspects of nurturing care was social support networks, whereas the greatest barrier was resource and time constraints of primary caregivers (mothers).
Conclusion
Interventions to support nurturing care in WK should focus on responsive caregiving and early learning opportunities. They should actively engage stakeholders working in this field in other regions of the country, be low cost, community-based, utilise and support social networks, and avoid placing additional burden on mothers.
Next Steps

In the next phase of this research, we will work with stakeholders and caregivers to co-design an intervention focused on supporting responsive caregiving and early learning opportunities in WK, in a way that is acceptable, relevant, and feasible.

O.05.10 - Neural correlates of face processing are associated with Theory of Mind development in early childhood

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Details

Objective: Examining whether infant neural responses to emotional faces are predictive of later behavioural outcomes.

Introduction: The ability to understand the mental states of others, i.e., theory of mind (ToM), is an important aspect of social cognition that emerges during early development. ToM is hypothesized to be closely related to the ability to process faces and recognize facial expressions, allowing one to interpret and act upon another person's emotions. The processing of faces is not determined solely by visual input, but also relies on interpreting the emotional content of the stimuli. Building on the understanding that there is overlap between brain regions involved in socio-cognitive processes, we examined whether infant neural responses to emotional faces were predictive of later behavioural outcomes. In the current study, we used functional near-infrared spectroscopy (fNIRS) and behavioural measures to probe the link between face processing and ToM and to test whether any associations are influenced by facial emotion expression. We hypothesized that responses in cortical brain areas associated with social cognition, including the prefrontal cortex and temporoparietal junction, would be associated with behavioural assessment of ToM. Specifically, it was predicted that increased cortical responses to emotional faces would be associated with better ToM performance, and that this relationship would be modulated by the emotional significance of the stimuli.

Methods: The analytic sample (N = 88) comprised participants recruited into a larger longitudinal study exploring the development of emotion processing in the first years of life. Neuroimaging data (fNIRS) were collected at infancy (*M* age = 8.2 months) during an emotional faces paradigm. At age 3 years (*M* age = 37.3 months), children completed a behavioural assessment for ToM (Wellman and Liu false belief task) and parents completed a questionnaire (Child Social Understanding Scale); scores from these measures were combined to create a composite ToM score.

Results: Multiple regression modeling indicated that neural responses to emotional faces in the dorsal middle frontal gyrus during infancy were positively associated with later ToM scores, $F(2,80) = 5.08$, $p = .01$ (Figure 1). A repeated measures ANOVA to test the main effect of emotion revealed a difference in oxygenated hemoglobin in the right temporoparietal for the different emotion types, $F(1,87) = 4.66$, $p = .03$. This was qualified by evidence for a significant negative association specific to the neural reponses

to angry faces in the right temporoparietal junction and ToM at 3 years, $F(2,86) = 3.41$, $p = .04$ (Figure 2), but not for happy or fearful faces.

Conclusion: These findings suggest that brain areas associated with emotion and face processing are responsive to emotional faces during the first year of life and that these neural responses may be predictive of later socio-cognitive development.

O.05.11 - Children's attention, learning schedule, and category learning in an overheard setting

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Details

From early infancy, children are exposed to language from various sources and in a variety of circumstances. To learn a language, specifically categories, children need to attend to the words and objects in their environments (Kannass & Oakes, 2008). Children's environments also affect children's category learning success, especially with how language and objects are presented in these environments (i.e., learning schedules; Vlach et al., 2012). Prior research has focused on children's category learning in direct interactions, even though it has been estimated that children spend less than a quarter of their day in direct interaction with a caregiver (Hoff & Naigles, 2002). Research has shown that children learn from overheard contexts – tuning into a conversation that do not include them (Akhtar et al., 2001). However, prior work has yet to examine how learning schedules affect children's attention and category learning in an overheard context. In overheard settings, children must maintain focus on the object the speaker is addressing, effectively allocating their attention, diverting their focus as needed, and sometimes switching attention between multiple events simultaneously. Without adult assistance, children rely on referential cues to connect the speaker's words to the relevant object.

In a novel noun generalization task, we compared twenty-seven children's (14 female, *M*age=2.4 years) category learning and attention. Participants were randomly assigned to one of two learning schedules in an overhearing setting: massed (exemplars presented in immediate succession) and spaced (exemplars presented in 15-second intervals). Building upon previous research, we hypothesized that children who attended longer to the target objects during the labeling event, regardless of the learning schedule, would demonstrate greater category learning performance than children who paid less attention during the labeling event.

An experimenter and a confederate conducted a finding game with hiding buckets. As each object was removed from the bucket, the experimenter told the confederate the name of the novel object. The child (as an onlooker) sat approximately four feet away. Participants completed eight training and testing trials for each novel category (Figure 1). The study session was recorded, and each video was coded frame-by-frame using Datavyu software (Datavyu Team, 2014). Coders categorized attention by examining children's eye gaze within each trial (*ICC*=.99, range=.97 - 1.00).

We examined children's correct responses out of eight trials in massed and spaced conditions to assess the impact of learning schedules on word learning. No significant differences were observed between

massed (*M*=2.8) and spaced (*M*=2.9) conditions, *t*(21.7)=-0.073, *p*=.94. As seen in Figure 2A, children's attention to the target object (calculated as the total duration in seconds) also did not differ significantly between massed (*M*=9.5) and spaced (*M*=5.8) conditions, *t*(19.2)=2.07, *p*=.05.

Given these results, we combined the massed and spaced conditions to examine the relationship between children's attention and correct responses. We found a significant positive correlation, indicating that children who spent more time attending to the target objects exhibited better category learning performance, *r*(25)=.4, *p*=.01 (Figure 2b). Our study highlights the importance of children's attention to object exemplars in facilitating successful category learning from overheard interactions. Future research should compare children's attention levels in the overhearing condition to a paradigm in which children receive direct instruction.

O.05.12 - The role of infant-caregiver interactions in the development of infant social cognition

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Details

Responsive infant-caregiver interactions have been argued to provide a critical context for the development of social cognition and behavior (Fonagy et al., 2007; Rochat & Striano, 1999). Infant-caregiver interactions likely provide rich opportunities for infants to (a) discover the intentional nature of others' actions, and (b) learn about others as social partners with whom to share attention and experience. Despite a robust literature on the development of social cognition in infancy, relatively little is known about the role of caregivers in this process. Thus, the goal of the current studies was to explore how individual differences in caregiver responsiveness during infant-caregiver interactions predict variability in infant social cognition in the first year of life.

Study 1 used a sample of 197 8-12-month-old infants (*M* = 9.33) and their caregivers to examine the association between caregiver responsiveness and infants' concurrent intention understanding and joint attention. Caregiver responsiveness was coded microanalytically from 8 minutes of free play. Scores represent the relative proportion of caregiver behaviors that maintain (rather than redirect) infants' focus of attention. Infant social cognition was also assessed at 8-12 months via measures of responding to joint attention (RJA; gaze- and point-following; Carpenter et al., 1998), initiating joint attention (IJA; using gestures and eye gaze to initiate joint attention with an experimenter; Mundy et al., 2003), and intentional action processing (making anticipatory looks to the goal of an agent's reaching action in an eye-tracking task; Brandone et al., 2019).

Study 1 results revealed considerable variability in caregiver behavior that predicted infant social-cognitive abilities. Specifically, at 8-12 months, caregiver responsiveness predicted infants' intentional action processing and their use of IJA gestures (but not their RJA performance) after controlling for infant age (Table 1). Thus, infants whose parents were more responsive during free play showed better concurrent intention understanding and produced more attempts to initiate joint attention with a social partner.

In Study 2, we used a subset of 110 infants who completed an additional lab visit at 6-7 months (*M* = 6.85) to examine whether early caregiver responsiveness longitudinally predicts later social cognition. Caregiver responsiveness was again coded microanalytically from free play and infants' tendency to engage in triadic interactions with objects and social partners was assessed through a semi-structured play session with an experimenter.

Study 2 results showed that, although caregiver responsiveness at 6-7 months was significantly related to infants' triadic engagement observed concurrently, $r(106) = .28$, $p = .003$, there was no evidence of longitudinal effects of early caregiver responsiveness on infant social cognition (intentional action understanding, IJA, RJA) at 8-12 months.

Overall, these results suggest that responsive caregiver behaviors that follow infants' focus of attention may lay the foundation for infants' ability to understand others' actions and engage in joint attention. These findings lend some support to the broader hypothesis that early social cognition is built within the context of social interactions. More research is needed to understand the precise mechanisms by which early caregiver behaviors shape infant social-cognitive development, including potential indirect paths through early infant interaction tendencies.

O.05.13 - The African Brain and Cognitive Development (AfriBCD) Network: a step towards better representation of developmental science in Africa

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Details

There is growing recognition that our understanding of neural and cognitive development is incomplete, as most research to date has been conducted on a small proportion of the world's population, predominantly in minority world settings where only 15% of the world's population live (Draper et al., 2022). As such, neurodevelopmental science needs stronger representation from more diverse populations around the world. AfriBCD is a network (currently 128 members) aimed at bringing together researchers and partners who are interested in neurodevelopmental research in Africa, spanning from pregnancy through infancy and childhood to adult life.

Drawing on the views of network members - who represent Africa (Gambia, Ghana, Kenya, Malawi, Nigeria, Rwanda, South Africa, Tanzania, Uganda, Zambia, Zimbabwe) and other international countries working with African partners
(Australia, Argentina, Canada, France, Germany, India, Ireland, Spain, UK, USA) - a survey was conducted

to understand the challenges and potential solutions for increasing infant and child developmental science studies in Africa. The highest rated challenges (from a total of 15 challenges outlined by survey data) include (i) translation and contextualization of measures and tools (and the time taken to do this), (ii) networking to build career path and (iii) capacity building, infrastructure and sustainability for more diverse work contexts (relative to Minority World contexts). Recommendations for addressing these challenges include (i) investing in building respectful partnerships (adequate time/funds for building partnerships, developing project ideas before the start of the project and maintain long term), (ii) increasing knowledge of networking opportunities that cross borders (i.e. online networks) and create partnerships (i.e. through AfriBCD) and (iii) funding for early career researchers and scholars 1 -2 years post PhD or following a career break. A further twelve solutions were also proposed and will be discussed in this presentation.

The key to the AfriBCD Network is co-creation and collaboration. We invite researchers and partners from African based institutions and around the world to partner with us in this endeavour.

O.06: Attention

O.06.01 - A convolutional neural network approach to understanding visual attention of infants and preschoolers

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Details

For decades, researchers have argued that infants' looking is influenced by visual complexity, and when infants are presented with simple patterns (e.g., checkerboards), they tend to look longer at complex patterns with more features (Berlyne, 1958; Cohen et al., 1975; Horowitz et al., 1972; Hutt & McGrew, 1969). However, defining visual complexity in naturalistic scenes remains challenging, often resulting in oversimplified, one-dimensional interpretations of complexity. Here, we present a novel quantitative approach to conceptualizing visual complexity. Our approach makes use of AlexNet, a convolutional neural network model based on the architecture of the ventral stream object recognition pathway. AlexNet takes as input images and produces activation in a series of layers in which the coded features become increasingly more complex, from V1-like representations of orientations to IT-like representations of complex features to even more abstract object representations. The essence of our approach is that the overall activation that a scene produces in a given layer reflects the complexity of that scene relative to that layer's level of abstraction, allowing us to describe complexity at different layers of abstraction. To investigate this framework, we recorded the looking patterns of three samples of children: 92 infants between 4 and12 months, 82 children between 12 and 48 months, and 47 children between 12 and 36 months. The participants engaged in a free-viewing task with digitized photographs of natural scenes. We analyzed five specific AlexNet layers to cover a range of visual processing stages. Layer Pool 2, akin to early visual processing, handles fundamental elements like corners, edges, and basic colors. Layer ReLU 5, representing intermediate processing, responds to

complex patterns and discrete object components (e.g., car wheels). Lastly, we explored the last layers of AlexNet, the fully connected layers, which are responsible for high-level object classification.

In general, children's looking duration was related to the activation in the different layers of AlexNet. Specifically, the two older samples looked longer at scenes with higher activations in all of the neural network layers, *p's* < .05 (Figure 1). That is, children preferred scenes that were more complex in the layers. However, the pattern differed for infants aged 4-12 months. Although the infants in this sample looked longer at scenes with higher activation (and therefore were more complex) at lower layers, their looking duration was not related to activations in AlexNet's last (most abstract) layer, FC3, *rs*(2574) = 0.02, *p* = .23. Additionally, we observed a shift over age in how much infants' looking was related to complexity in the low-level layer of the neural network. Compared to younger infants, older infants had a stronger preference for images that were more complex in Pool 2 (ß = .90, z = 8.81, *p* < .001) (Figure 2). These findings align with existing literature, suggesting a developmental shift in which attention is more strongly influenced by low-level image properties (i.e., physical salience) in young infants to being influenced by higher-order object properties over the following months and years. The results of our current study demonstrate that infant looking times can be predicted by our quantitative model of complexity, and that complexity based on higher levels of visual abstraction has an increasing impact on looking time as children develop.

O.06.02 - Evaluating visual attention development by relating infant eye movements to adult fMRI data

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Details

Across the first year of life, infants' visual attention develops rapidly: young infants' eye movements are initially reflexive and driven by stimulus properties but become increasingly voluntary and influenced by goals, familiarity, and social significance (Colombo, 2001). However, as visual attention develops in the first year, nearly all other aspects of infants' lives also undergo significant changes. They learn to locomote, produce language, and develop meaningful relationships with caregivers, while simultaneously undergoing physiological changes such as increased cortical maturation and visual acuity. Recent developmental theory argues that these various changes may interact and create cascading influences on infants' visual attention development (Oakes, 2023). A critical step in understanding how this cascade unfolds is being able to effectively measure the roles of each factor that contributes to visual attention development. However, directly measuring physiological changes in visual cortex during infancy is challenging (Aslin et al., 2015). Therefore, until recently, the relationship between infants' visual attention development and the successive levels of the cortical processing hierarchy remained largely theoretical. Kiat et al. (2022) addressed this question empirically by relating infants' pattern of fixations to AlexNet, a convolutional neural network (CNN) model inspired by the ventral stream. In adults, early layers of AlexNet are more strongly related to activity in low-level visual areas, whereas later layers tend to be more related to higher-level regions. In infants, Kiat et al. found that early layers of the model were more related to the gaze patterns of younger infants and later layers

were more related to the gaze patterns of older infants. These findings suggest that gaze becomes increasingly controlled by abstract, high-level representations over development. However, the link between AlexNet and specific areas of visual cortex is indirect and approximate. In the present study, we leveraged the Natural Scenes Dataset to address this limitation (NSD; Allen et al., 2021). The NSD dataset contains measurements of 7T fMRI responses from 8 adult participants who each viewed 9,000–10,000 naturalistic scenes. We recorded the eye movements of 42 11-month-old infants as they viewed up to 50 scenes from the NSD dataset (Figure 1A). We used representational similarity analysis to evaluate the link between infant gaze patterns and adults' cortical activation for these scenes (Figure 1B, C). Preliminary findings suggest that infants' fixations are more strongly related to the patterns of activation observed in early- to mid-level regions of the ventral stream (i.e., V1 through inferior occipital sulcus, IOS) compared to the highest-order cortical region in the ventral stream spanning from inferior occipital sulcus to the midpoint of the occipital temporal sulcus (OTS; Figure 2). Final analyses will compare these data to eye movements of younger (i.e., 5-month-old) infants to examine whether gaze becomes increasingly controlled by abstract, high-level representations consistent with higher-level cortical processing across infancy. These initial results demonstrate the feasibility of using the NSD dataset to link infant gaze behavior to cortical processing, offering valuable insight into the factors guiding visual attention development.

O.06.03 - Is infants' joint attention related to parent-infant conversational turn taking?

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Details

Infants actively participate in communication long before they participate in speech-based conversations. A central role for participation in conversations is joint attention (JA). If children are competent in JA they are also able to participate in more successful conversational turns. In the present study children's joint attention abilities were measured with the Early Social Communication Scale (ESCS, Mundy) and children's conversational turns were assessed with the Language Environment Analysis (LENA). At the age of 9 months, 85 children visited the Infant and Child Lab, Linköping, Sweden, with their parent and engaged in structured play according to ESCS. Of main interest were four JA measures as defined by Mundy: 1. Using eye contact to initiate JA, 2. Using pointing or showing to initiate JA, 3. Responding to proximal pointing from an experimenter, 4. Responding to experimenter's pointing in experimenter's line of regard (for descriptives Table 1).

Parents recorded the child's language environment for a full day. The recordings were automatically analyzed by LENA software, yielding several measures of which parent-infant turn-taking counts are analyzed here (for descriptives Table 1).

We found a significant positive correlation between the infants' pointing and showing to initiate JA with the experimenter and parent-infant turn-taking ($r = .32$, $p < .01$, Table 2). Infants' ability to use eye contact to initiate JA was not related to parent-infant turn-taking. Parent-infant turn-taking seems to relate to explicit attempts from the infant to initiate JA, but not to more subtle attempts such as eye gaze. Further, infants' ability to respond to experimenter's proximal pointing was also significantly

related to parent-infant turn-taking (r = .32, p < .01, Table 2), but infants' response to experimenter's pointing in the experimenter's line of regard was not related to parent-infant turn-taking. However, 9-month-olds are not expected to easily show target behavior in this task and the low mean score indicates that few have done so (Table 1).

It is interesting to note that a structured lab-based activity with a stranger designed to elicit JA behavior is related to parent-infant successful (or well-timed) conversational turns. Both initiating JA and responding to JA is related to conversational turn-taking between parents and infants in the home environment. At 9 month of age infants who use pointing at and show of items as part of JA activities experience more conversational turns just as infants who response appropriately to other's pointing at proximal objects. These findings are consistent with recent studies showing that in attention to mutual gaze, the majority of joint attention episodes initiated by adults include multi-modal cues (synchronous language and gestures) that shape infant attention and communication (Suarez Rivera et al., 2019).

O.06.04 - Early social sensitivity: Infants show social inhibition of overt attention

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Details

Eye movements are affected by the social context we are in: Studies with adults suggest that they preferentially look at strangers in videos while they inhibit looking at strangers during face-to-face scenarios (e.g., in a waiting room). Despite these previous findings, however, the development of social inhibition of gaze has never been directly investigated. Therefore, the current preregistered (https://osf.io/837wm) set of studies co-registered eye-tracking and electroencephalography to better understand the development of this process by comparing eye movements and neural responses during a "waiting room situation." Participants were seated and asked to wait in a room in which either a real confederate was present (live social condition) or a video of the same confederate was presented on a computer screen (video condition, Figure 1). Study 1 tested 3-7-month-old infants (n = 20) and adults (n = 20) and showed that both age groups looked significantly longer at the confederate in the video condition than in the live social condition (infants' gaze, $t(19) = -2.26$, $p = .036$, $d = 0.505$; adults' gaze, $t(19) = -4.0568$, $p < .001$, $d = .907$, Figure 2), even though their neural responses suggest that they were equally attentive in both conditions (infants' alpha power, $t(13) = 1.96$, $p = .072$, $d = 0.52$; adults' alpha power, $t(15) = -0.06$, $p = .956$, $d = 0.01$). The gaze difference increased with age, $F(1, 38) = 8.60$, $p = .006$, suggesting that inhibition of gaze develops between infancy and adulthood. Following current findings, Study 2 tested the specific components of conditions which effect social inhibition of gaze in infants (n = 20) between 3 and 5 months. The emotional expression of the confederate, as well as the interaction between confederate and infant was manipulated to investigate conditions under which infants look at a stranger. The findings suggest that social awareness and implicit following of social rules develop very early during infancy and that infants are already highly sensitive to the social context around them.

O.06.05 - From crib to screen: understanding the links between screen time and infant attention

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Details

Attention in infancy is regarded as a foundational skill crucial for the development of more complex abilities like self-regulation and executive function (Posner & Rothbart, 1998). *Exogenous attention* emerges as an automatic response to salient stimuli, while *endogenous attention* allows children to control and sustain their focus (Colombo & Salley, 2015). Limited evidence suggests that 18-month-old infants engaging more with touchscreens exhibit faster detection of stimuli and earlier attention to emerging stimuli on the screen than less frequent users (Portugal et al., 2021a, 2021b), indicating a link between touchscreen use and heightened exogenous attention. The present study aimed to explore the relationship between total screen time (on television, tablet computers, and smartphones) and exogenous and endogenous attention in infants aged 9 to 16 months, a critical developmental period for attentional skills (Ruff & Rothbart, 1996). We hypothesized a negative association with endogenous attention and a positive association with exogenous attention.

A total of 110 infants (*M*(*SD*) = 11.9(1.4); *age range* = 9.7-15.9 months) participated in the study. First, infants completed the antisaccade task (Johnson, 1995), in which a dynamic target stimulus appeared on the opposite side of the cue stimulus on the screen in each of the 24 trials. Antisaccades, where infants anticipatorily looked at the target location, measured endogenous attention. Prosaccades, where infants looked at the distractor and target stimuli without an anticipatory look, measured exogenous attention. Then, infants completed the distractibility task (Salley et al., 2012) to assess endogenous attention. In each of the six trials, a speaker narrated a story, and a peripheral distractor stimulus appeared on the corner of the screen. The percentage of trials with infants gazing at the distractor measured distractibility. During both tasks, infants' gazes were recorded. Caregivers reported infants' daily screen time on different devices.

Table 1 shows the descriptive statistics and correlations between variables. Contrary to our hypothesis, screen time was not associated with distractibility. For the antisaccade task, anticipatory looks measuring endogenous attention were rare (3% of valid trials) and not further analyzed. However, as hypothesized, reaction time toward the target stimulus in prosaccades measuring exogenous attention exhibited a negative association with screen time, $r(80) = -.29$, $p = .009$. In other words, infants with increased screen time demonstrated quicker responses in looking at the target stimulus without anticipatory reaction, indicating heightened exogenous attention.

The significant association between screen time and exogenous attention implies that exposure to screen media encourages rapid attentional shifts and scanning behaviors, resulting in shorter reaction times to salient stimuli. Our findings contribute to the literature on screen media use and attention in two significant ways. Firstly, our study incorporates behavioral measures of attention, challenging the predominant reliance on parental reports (Gordon-Hacker & Gueron-Sela, 2020). Second, while the existing literature predominantly centers on preschool-aged children (Courage, 2017), our focus on the first two years of life aligns with suggestions that the detrimental impacts of screen time may be more pronounced during this critical period (Jourdren et al., 2023).

O.06.06 - Understanding the links between attention, multiple types of memory and vocabulary development in toddlers

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Details

The "shape bias" is the tendency of both children and adults to generalise newly learned names for solid objects based on shape similarity (Smith et al., 2002). Research conducted over the last 30 years has linked the development of the shape bias to the early noun vocabulary: children learn many names for categories organized by shape similarity (Perry & Samuelson, 2011; Samuelson, 2002) and only after show the bias in novel noun generalization (NNG) tasks and late talking children do not show a shape bias (Jones, 2003).

Recent research by Bakopoulou et al. (2023) replicated the relationship between the shape bias and vocabulary in typically developing 2-year-olds. They also demonstrated a relation between visual attention in the NNG task and vocabulary—children who knew more nouns were faster to look at shape-matching test objects, and made fewer transitions between objects when generalizing novel nouns. They suggested one possible reason for this was that children who knew fewer nouns needed to refresh their working memory (WM) representations of the objects before making generalization decision (c.f., Vales & Smith, 2015, 2018).This idea fits with recent work linking vocabulary development to multiple memory systems. Children who have better object memory are better in learning new words (Vlach & DeBrock, 2019) and pre-schoolers with specific language impairment struggle to learn pairs of visual objects and do not develop shape bias (Collisson et al., 2015). Likewise, a recent meta-analysis by Pickering et al. (2021) emphasized the importance of visual memory in vocabulary development.

In this talk I will present data from a study examining relations between the shape bias, children's vocabulary, visual attention, and memory. We used an eye-tracker to get fine-grained measures of children's attention during a NNG task (Figure1) with 3D stimuli and collected data on children's vocabulary, visual working memory (VWM), object memory and retention of novel names presented in the NNG task from 70, 18- to 26-month-old children.

Analysis of data from individual tasks replicate prior findings. There is a relationship between noun vocabulary and the shape bias (p=.02) such that children who know more words demonstrate a stronger bias. In addition, children who know fewer names are both slower to look to the eventually-selected test objects in (p= .02, Figure 2a) and do more transitions between objects prior to making a generalization decision (p= .01). VWM data indicate that younger children are more prone to shifting attention (p= .03) and struggle to maintain more than 2 objects in working memory (p= .06).

Analysis of relationships between tasks is ongoing, following our pre-registration (https://doi.org/10.17605/OSF.IO/G3RNX), but preliminary analysis suggest children who know fewer nouns but have stronger VWM retain names from the NNG task better (p=.02, Figure2b). Additional analyses will look at relations between VWM, object memory and attention to shape when generalizing nouns as well as these measures and vocabulary. The findings will be discussed in the context of prior proposals regarding a developmental cascade of multiple attentional and memory systems supporting early word learning.

O.06.07 - Infants' attention to own-race and other-race faces in the first two years of life varies by the diversity of social experiences

Sophie Arnold [1], **Nicole Burke** [1], **Rachel Leshin** [1], **Marjorie Rhodes** [1]

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Details

The present project examined how infants growing up in environments with varying degrees of diversity attend to faces of people from different racial groups across the first two years of life. Early biases in looking behavior have been proposed to be an important precursor to the later development of racial biases, but it is unknown how these biases change across infancy and vary across diverse environments and experiences. We addressed this question via a large-scale, longitudinal sample of infants in the United States. 202 3- to 14-month-old infants participated in Wave 1 (M_{age} = 6.9 months, SD_{age} = 2.8 months, 53% female, 47% male, 65% monoracial-white, 35% infants of color). Three months after Wave 1, these infants were invited to Wave 2 (N = 126, M_{age} = 10.2, SD_{age} = 3.0, 55% female, 45% male, 63% monoracial-white, 37% infants of color), and six months after Wave 1, they were invited to Wave 3 (N = 106, M_{age} = 13.3, SD_{age} = 2.9, 56% female, 44% male, 65% monoracial-white, 35% infants of color). At 2.5 years old, toddlers who had participated in Wave 1 were invited to participate in a follow-up study (data collection ongoing, current n = 22). Infants were tested from all across the U.S. using an unmoderated platform (Rhodes et al., 2020), which provided a unique opportunity to capture natural variation in infants' exposure to racial diversity with a sample including 40 states and 196 unique ZIP codes. To capture this variation, parents at each wave completed *The Child Social Network Questionnaire* (Burke et al., 2022), which captures information about who infants interacted with in the last two weeks. From this survey, we extracted our measure of exposure to racial diversity in infants' close social contacts, and from parents' self-reported ZIP codes, we extracted the racial demographics of infants' neighborhoods (using the U.S. Census). Across all waves, younger infants (less than 12.7 months) looked longer at other-race than own-race faces (see Fig. 1), whereas older infants did not differentiate their looking to own-race and other-race faces. Further, these effects were moderated by the diversity of infants' close social networks (but not the diversity of their neighborhoods): infants with any diversity in their social networks did not differentiate their looking to own-race and other-race faces, regardless of age (see Figure 2), while younger infants with no diversity in their social network looked longer at other-race than other-race faces, and this visual bias was attenuated with age (see Figure 2). These findings suggest that exposure to diversity within infants' close social networks—but not broader neighborhoods—relates to their early looking behavior. In ongoing work, we are collecting data from these same babies as toddlers to examine whether visual biases in infancy and/or early experiences with diversity relate to early emerging social biases (i.e., choosing who to be friends with: an own-race or other-race child). In doing so, we aim to shed light on whether and how early experiences and behaviors relate to the development of racial bias.

O.06.08 - Caregiver prosody is contingent on infant sustained visual attention

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Details

In early life, mature social partners scaffold and support a variety of cognitive achievements and developmental milestones. Parent behavior during one-on-one, free-flowing play supports sustained visual attention (SVA). When a caregiver looks to, talks about, or touches an object, an infant is more likely to sustain their attention to it (Suarez-Rivera et al. 2019). SVA is an important behavior; infants who spend more time sustaining their visual attention to an object go on to develop greater visual attention (Richards & Casey 1992), self-control (Reck & Hund 2011), better language development (Yu et al. 2019), and better school achievement (McClelland & Cameron 2019). Despite its importance, the moment-to-moment social dynamics of how SVA is initiated, guided, and maintained is less understood. Emerging literature suggests one viable pathway for caregiver influence on infant SVA is through prosodic infant-directed speech (Nencheva et al. 2020). Furthermore, extant research has found that during the first year of life, infants are largely reactive of caregiver behaviors (Wass et al. 2023). Thus, the current study aims to gain a mechanistic understanding of different prosodic contours and their influences on infant sustained attention.

Data included a cohort of 12-15 and 21-24, month old infants (44 unique infants over 65 sessions) participating in tabletop play with their caregivers. The prosodic contours of 11,647 caregiver utterances were extracted and reduced in dimensionality, where K-means clustering found 7 unique categories of prosody (Figure 1). These include hill, rise, fall, and valley contours (and combinations thereof - similar to Nencheva et al. 2020). Visual attention was measured using head-mounted eye-trackers and defined as an unbroken look to an object equal to or longer than 3 seconds. We calculated the probability of a caregiver utterance occurring given the onset of sustained visual attention. Chance regions were calculated for each category of prosody using 95% confidence intervals from a permutation test for significance. Portions of time were considered significant if chance was exceeded for at least 200ms.

In the younger age group, caregivers were significantly likely to use fall-to-hill and rise contours before the onset of infant SVA (Figure 2). However, in the older group, caregivers became significantly more likely to use other types of prosody (rise-to-valley, fall, valley, and rise) just before the onset of infant SVA, as well as around the average duration of SVA. This may suggest that caregivers are using different prosodic contours to initiate or break infant SVA.

Future analyses will consider the leader-follower dynamics in interactions, as well as the semantic contexts in which vocalization clusters are used and the individual variability between caregivers.

O.06.09 - The role of heart rate deceleration as a mechanism in infant sustained attention

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Details

Introduction: One of the well-studied infant sustained attention (SA) models proposes that infant SA is indicated by a heart-rate (HR) deceleration and decreased HR level compared to inattention or baseline (e.g., pre-stimulus presentation) (Colombo, 2001). During SA, there is an observed enhancement in information processing of external stimuli (Richards, 2010; Xie et al., 2018). The enhanced information processing has been attributed to the general brain arousal ("energizing") model, in which the reciprocal connections between the mesencephalic reticular activating system and the cortex strengthen during SA, subsequently affecting the thalamus and promoting neurotransmitter release (e.g., norepinephrine) (Reynolds & Richards, 2007). The HR deceleration serves as an indicator of attention in this model, reflecting the presence of the arousal system (Richards, 2007, 2008). **However, is the HR deceleration during SA also a mechanism that influences information processing?** This is a possibility, as HR deceleration primarily occurs due to the prolongation of the diastolic phase, during which there is an enhanced perception of the external environment and relatively inhibited interoception of the heart (Critchley & Garfinkel, 2018). Therefore, the increased processing of external stimuli during SA may be attributed to more stimuli coinciding with the diastolic phase, leading to heightened neural responses. Currently, there is no evidence regarding infants' interoception and its interaction with attention in the processing of external stimuli. This study aims to address this lack of knowledge by examining the visual evoked potentials (VEPs) of infants aged 6 to 18 months in response to flanking checkboard stimuli and how these neural responses change based on cardiac and SA phases.

Methods: In the current analysis, 29 infants (15 females) between the ages of 7 and 15 months (mean age = 10.20 months, SD = 2.31 months) were included. The checkboard stimulus flickered at a rate of 3Hz for 20 seconds in each block, alternating between black-white and red-green checkboards. Infant ECG and EEG were recorded simultaneously using a 64-electrode R-Net system. Based on the peak latency of the R- and T-wave (Figure 1), three cardiac phases were defined: diastole1 (R to following 150 ms), systole (T to following 200 ms), and diastole2 (150 ms to the subsequent R). Consequently, the visual stimuli (checkboard flashing) were assigned to one of these three conditions based on their presentation timing.

Results: The P2 mean amplitude was significantly influenced by the cardiac phase, F (2,28) = 5.61, p = .011, $\eta 2$ = .167. Stimuli presented during diastole elicited greater P2 responses compared to those presented during systole (Figure 2). This suggests that interoception has an impact on infants' neural responses to external stimuli, indicating that HR deceleration during SA may not only be a result but also a contributing factor to enhanced information processing.

Ongoing: Data collection remains ongoing, so does the analysis of the interaction between cardiac phases and SA.

O.06.10 - Is early engagement in joint attention events unique to humans?

KATIE SLOCOMBE [1], **Nicole Lahiff** [2], **Claudia Wilke** [1], **Kirsty Graham** [1], **Joanna Buryn-Weitzel** [1], **Eve Holden** [1], **Santa Atim** [3], **Ed Donnellan** [1], **Maggie Hoffman** [4], **Michael Jurua** [3], **Charlotte Knapper** [1], **Sophie Marshall** [1], **Josephine Paricia** [3], **Dyah Perwitasari-Farajallah8** [5], **Florence Tusiime** [3], **Klaus Zuberbuhler** [6], **David Watts** [7]

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Details

Sharing attention with another individual about an external object or event is an important milestone in early human development that typically emerges at 9 months of age (Tomasello, 1995; Mundy & Newell, 2007). Engagement in joint attention events and proficiency with joint attention skills in infancy have been found to positively predict later social cognition and language abilities (e.g. Brandone & Stout, 2022; Salo et al., 2018; Lasch et al., 2022). Joint attention is also a key element of 'shared intentionality', a cognitive ability that is purportedly unique to humans (Tomasello et al., 2005). From an evolutionary perspective, joint attention represents a crucial building block that likely supported the evolution of complex cooperation and language in our lineage (Tomasello et al., 2005). Despite its ontogenetic and evolutionary importance, it remains unclear how joint attention evolved and whether it is indeed unique to humans. Comparative data are vital for addressing these issues, but until now have failed to standardise either methods (e.g., researchers have used cross-species testing for non-humans versus conspecific testing for humans (e.g. Carpenter et al., 1995)), or operational definitions of joint attention across studies and species (Graham et al., 2021). Here, we level the playing field and present novel visual stimuli to mother-infant dyads from multiple populations of humans (N = 24), wild chimpanzees (N = 47), and wild crested macaques (N = 31) in their home environment or natural habitat. All groups were presented with the moving light of a laser pen and non-human groups were also presented with highly reflective metal balls. The human dyads were 11-month-old infants and their mothers, living in or around the city of York, UK (N=12) or in rural Masindi District, Uganda (N = 12). We applied a rigorous multi-level definition of engagement in joint attention events to evaluate dyads' responses (Figure 1). At the highest level we required both individuals to look at the visual stimulus immediately before engaging in mutual gaze during which both partners communicated (facial, gestural, or vocal signal; Figure 1). Communication is key as it makes the jointness of the interaction manifest both to interaction partners and to observers (Siposova & Carpenter, 2019). We found that all three species engaged in this highest level of joint attention event in which both individuals communicated about the stimulus (see Figure 2 for examples from human and macaque trials). This challenges the assumption that only humans engage in joint attention events and shows for the first time that monkeys can engage in joint attention events. These findings indicate that the evolutionary origins of joint attention may be more ancient than previously thought. When directly comparing behaviour of dyads towards the same novel visual stimuli (moving light of a laser pen), we also found important species differences, with humans engaging in joint attention events with at significantly higher rates than chimpanzees and macaques. Our findings suggest that humans and other primates exhibit a quantitative rather than qualitative difference in joint attention events, which future research must seek to understand.

O.06.11 - Prenatal roots of MSI: tracking the emergence of (multi)sensory perception with Ultrasound and fetal eye-lens movements

Karol Poles [1], **Alice Rossi Sebastiano** [1], **Marcella Romeo** [2], **Roberta Nastruzzo** [1], **Manuela Oberto** [1], **Tullia Todros** [1], **Pietro Gaglioti** [1], **Francesca Garbarini** [1]

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Details

Converging behavioral and electrophysiological evidence showed that multisensory integration (MSI) is already present at birth. Indeed, by exploiting the eye-fixations, the presence of cross-modal congruency effects in newborns has been showed (Filippetti et al., Curr Bio, 2013). Moreover, previous studies

highlighted greater eye-fixation (Orioli et al., Curr Bio, 2018) and enhanced ERPs (Ronga et al., PNAS, 2021) in response to multimodal (vs unimodal) stimuli occurring near to the newborn's body, thus suggesting a primitive spatial coding of body-self boundaries. However, when and how MSI emerges in the prenatal period is still unknown. Capitalizing on our previous study (Ronga et al., Dev Sci; under review), wherein we successfully recorded fetal eye-movements in response to salient visual stimuli, we aim to explore the fetal (multi)sensory engagement at its very beginning. Specifically, we intend to code eye-lens movements of 3rd-trimester fetuses to systematically study stimulus-driven responses to both uni- and multimodal stimuli. As a first step, in a pilot phase presented here, we explored the feasibility of recording visual orienting responses during unisensory modalities different from vision (i.e., auditory) by tracking the fetal eye-lens movements through 2D-Ultrasound (Fig.1). Currently, a total of 34 recordings of fetuses (N=17) were collected along the 3rd trimester and at different timepoints (tp1: 27±1; tp2: 33±1; tp3: 37±1 weeks) during the administration of 500Hz pure-tones (1s). A total of 10 stimuli (randomized-order) were delivered via one of the two loudspeakers accurately placed on the mother's abdomen, respectively, to the left and to the right of the fetal head position. Fetal eye-lens movements and head turns recorded (5s) pre- and (5s) post-stimulation were separately online and offline coded by expert sonographers. Results (Fig.2a) showed a significant difference ($F31=38,7$; $p<.0001$) with overall greater fetal responses coded in the post-stimulation period (33.7%) as compared to the pre-stimulation (16.8%). Although on the total acquisitions 89% of trials resulted encodable for eye-lens and 94% for head movements, comparing the type of fetal responses (Fig.2b) we found a significantly greater percentage ($F31=19,5$; $p<.001$) of responses coded with the eye-lens movements (34.2%) as compared to head turns (16.3%). Importantly, we found a Sequence*Marker interaction (Fig.2c), with fetal eye-lens responses in the post-stimulations significantly greater (46.2%) than the other conditions (all $ps<.0001$; Bonferroni Post Hoc test). No significant differences were found between timepoints, suggesting that such a pattern was similar along the third trimester. These preliminary data show, for the first time, the feasibility of recording eye movements in response to acoustic stimulations, with eye-lens movements representing a sensitive and reliable stimulus-locked measure for the coding of fetal responses in the whole 3rd trimester of gestation. As a next step, we will analyze whether fetal responses are also oriented toward the stimulation side. Furthermore, we will collect data employing vibrotactile stimulations. Finally, we will employ such a promising measure of fetal attention orienting with cross-modal stimulations to investigate when MSI emerges through gestation and is modulated by the proximity to the body, thus exploring the emergence of a primitive coding of body-self boundaries in utero.

O.06.12 - Unveiling infant surprise: a comprehensive analysis of physiological, behavioural, and facial expression markers

Romain Di Stasi [1], **Fabien Cerrotti** [2], **Lauriane Rat-Fischer** [1], **Rana Esseily** [1]

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Details

Surprise underlies various emotions and plays a role in many cognitive processes. Due to its short and transient nature, surprise is very difficult to detect, especially in infants who, unlike adults, cannot verbally communicate about their emotions. In infants, the most employed measures used to identify surprise are 'fixation time,' which refers to the duration spent looking toward an event, and facial expressions, using a

methodology known as 'BabyFACS'. Infants' facial expressions are not always reliable for detecting surprise since they can often be produced during other cognitive processes involving attention. Fixation time is a reliable indicator of surprise in setups using events displayed on a screen, however it is less efficient in live setups involving social interactions. In social contexts, infants' gaze can quickly be redirected toward various social stimuli, diminishing their detectability. The goal of the current study is to validate a methodology for measuring infants' surprise during a social interaction event. We analyzed data from 100 infants, aged between 14 and 22 months, exposed either to a surprising demonstration (using humor as a trigger of surprise) or a neutral one. The humorous demonstration involved the repetition of five identical surprising event (*i.e.*, throwing a toy over the demonstrator's shoulder after retrieving it with a rake), whereas the neutral demonstration involved the same raking movement, but without the throwing action. We simultaneously measured and analyzed several indicators of surprise during both types of demonstrations facial expressions of surprise (using the BabyFace Reader software by Noldus), gaze (fixation duration toward the demonstrator), physiological measures (using the E4 Empatica connected wristband to measure heart rate and electrodermal activity) and accelerometry of infants' ankle (as an indicator of 'freezing'). For the automated facial expression analysis, we designed three algorithms based on criteria used to identify surprise and extracted from the FACS and BabyFACS literature. First, we found that accelerometry was the most reliable indicator to identify the initial surprising events in the demonstration. Infants had a significant reduction in motor activity during the humorous demonstration as compared to the neutral one, but only during the second surprising event (Fig1). This aligns with the literature in adults reporting that surprise is characterized by a brief interruption in motor activity termed 'freezing behavior' or 'stilling behavior'. Second, we found that infants exhibited more facial expressions of surprise (Fig2) and gazes toward the experimenter during the humorous demonstration than during the neutral one. This difference was present during three to five of the surprising events, and not only following the first one. Thus, these indicators may not specifically identify surprise *per se*, but could rather be associated with an attentional process triggered by surprise. Finally, our online physiological measures (heart rate and electrodermal activity) did not show specific patterns of activity during surprising events comparatively to neutral ones. Together, our results suggest that while surprise facial expressions and gaze towards the experimenter can be good indicators of surprise, only motor activity interruption accelerometry is a reliable indicator of the initial surprise event.

O.07: New Methods

O.07.02 - NIH baby toolbox language domain

Y. Catherine Han [1], **Miriam Novack** [1], **Elizabeth Dworak** [1], **Sandra Waxman** [1], **Adriana Weisleder** [1], **Michael Frank** [2], **Jenny Saffran** [3], **Richard Gershon** [1]

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Details

Motivation: The NIH Infant and Toddler Toolbox (Baby Toolbox) is a novel standardized assessment for infants aged 1 through 42 months, administered entirely on an iPad tablet equipped with automatic coding and scoring. This abstract describes the measures included in the Language domain and preliminary evidence for their reliability and validity.

Tasks and development: Measures of receptive and expressive language were selected by a team of language experts, informed by input from an expert survey of over 400 clinicians and researchers, and a scoping review of the literature. Measures selected and adapted for iPad administration include a Looking while Listening (LwL) task, NIH Toolbox Picture Vocabulary Test (PVT), adapted versions of the Mullen Expressive (ME) and Mullen Receptive (MR) tests, as well as computerized adaptive test (CAT) versions of the MacArthur Communicative Development Inventories (CDI) Receptive and Expressive questionnaires. Versions of each measure were also developed in Spanish. All measures were normed and validated against gold standard assessments (Bayley Scales for Infant Development 4th Edition, or Bayley-4, and Ages and Stages Questionnaire 3rd edition, or ASQ-3), in a sample of 2550 infants between the ages of 1- and 48-months representative of the racial and ethnic diversity of the United States.

Results: At the time of this submission (November 2023), norming testing is ongoing, but expected to be completed by the end of December 2023. Here, we focus our analyses on a subset of data available at the time of the ICIS submission, which includes 1544 infants across the full age range who completed at least one of the measures in English. Preliminary results for these measures show moderate to strong correlations with age (rs = .55-.86), See Table 1. Final results for the full English-speaking sample will be completed in early 2024.

Discussion and Future Directions: The Baby Toolbox is envisioned as "common currency" for developmental research and clinical use. Measures in the language domain reflect modern approaches to standardized assessments and are expected to be of great interest when the Baby Toolbox is released in late 2024. Ongoing analyses are generating item response theory models, and composite scores, all of which will be validated against other gold-standard measurements (Bayley-4 and ASQ-3). Future analyses will also separately validate all measures in Spanish. Final scores will include age-adjusted norms available in both English and Spanish.

O.07.03 - An integrated EEG-eye-tracking approach for the study of social and non-social audiovisual processing in toddlers at elevated likelihood for autism

Valentina Riva [1], **Elena Capelli** [2], **Lucia Billeci** [3], **Giulio Federico** [4], **Maddalena Cassa** [1], **Elena Riboldi** [2], **Chiara Cantiani** [1], **Carolina Beretta** [2], **Massimo Molteni** [1]

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Details

Phenotypic heterogeneity is a crucial characteristic of the actual conceptualization of autism spectrum disorder (ASD). This heterogeneity is expressed in individual variation not only in the severity of core symptoms but also in cognitive, language, and adaptive skills, which show different developmental trajectories. In addition, there is a strong interest in identifying reliable behavioral and brain-based predictors, which may constitute useful tools for early detection of at-risk cases. Notably, autistic individuals perform poorly during conditions that require integration across multiple sensory modalities such as audiovisual (AV) sensory integration and process social and non-social stimuli differently compared to typically developing (TD) counterparts. However, the study of potential interaction between AV sensory and social processing in the first years of life is still scarce and no study examined

early social and sensory markers in infant siblings of autistic children (EL-ASD) using integrated experimental techniques.
The study integrates electroencephalographic (EEG) and eye-tracking (pupillometry) measures (1) to characterize AV sensory processing in social and non-social conditions in EL-ASD compared to TD toddlers, and (2) to investigate the association between early social and non-social sensory skills and the clinical outcome measures.
This research is part of a larger longitudinal study on EL-ASD infant siblings, wherein infants are monitored from 3 to 36 months of age using a multi-observational protocol. The present study includes EL-ASD and TD toddlers recruited at 18 months and a follow-up evaluation is collected at 24 months. At both time-points, all toddlers are assessed with an experimental protocol including behavioral and neurophysiological measures. The integrated EEG-eye-tracking task focuses on AV sensory processing in social (face saying "wow" in infant-directed speech) and non-social (spinning top toy) conditions (Figure 1). The videos are presented both in synchronous and asynchronous modalities (1000 ms delay audio presentation), and four conditions are considered (SOC/SYNCH, SOC/ASYNCH, NONSOC/SYNCH, NONSOC/ASYNCH).
Pupillometry parameters (pupil dilations) are recorded using a Tobii ProSpectrum 300 Hz system. EEG alpha (8-12 Hz) and theta (4-7 Hz) power oscillations are analyzed, both in frontal and temporal areas, recorded by EGI High-Density EEG 128-channel system.
The pupillometry results showed that in the last part of the presentation of the stimuli (~3000 ms), both groups showed greater pupil dilations for asynchronous conditions compared to synchronous conditions at 18 months of age (Figure 2a), potentially indicating an increase in cognitive processing load and/or engagement due to the conflicting nature of asynchronous sensory cues. Notably, the EL-ASD group seems to show greater pupil dilations for non-social conditions compared to TD, suggesting between-group differences in the “salience processing” of social characteristics.
Our EEG preliminary results show higher relative alpha power in TD compared to EL-ASD children for all conditions both in frontal and temporal areas (Figure 2b). Interestingly, the TD group seems to show different relative alpha power for social and non-social conditions in frontal and temporal areas. No significant differences are found in the EL-ASD group. Data collection is ongoing and the association between experimental data and later clinical outcome will be reported. These results could generate new leads on targets for early intervention for neurodevelopmental disorders.

O.07.04 - Collaborative analyses in infancy research: general guidelines and avoiding pitfalls

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Details

The rise of big-team science (BTS) in recent years creates new ways to think about and carry out research, with many associated challenges including how to set up collaborations (Baumgartner et al., 2023). We have witnessed such projects in our own field with the emergence and growth of the ManyBabies consortium. In this presentation, we focus on a complementary approach to collaborative research: parallel analyses. It is now recognized that a single-analysis pipeline will lead to idiosyncratic results (Hoogeveen et al., 2023; Schweinsberg et al., 2021; Silberzahn et al., 2018). This pipeline stems from both the long tradition of small-team research and the impetus to minimize the family-wise error rate of

statistical tests. Unfortunately, the near-ubiquity of the single-analysis pipeline persists, including in other collaborative endeavors such as the first two published ManyBabies projects (Byers-Heinlein et al., 2021; Steffan et al., 2023). With the growth of collaborative research and the increasing use of pre-registration of projects which protects research and findings from the outcomes of significance testing, the time is ripe to rethink how we analyze data.

A recent paper on which the two presenters served as project lead and journal editor examined whether and how different analysis strategies, used with the same dependent variable in infant research, would produce findings that converge when applied to the same dataset (Blinded, 2023). The project used a crowdsourcing approach to recruit collaborators, yielding seven distinct interim conclusions about the data. The discussion highlights both convergences, which likely reveal genuine effects, and divergences, which can reveal weaker effects and/or parametric decisions and/or analytical artifacts. Our unique perspective on this project allows us now to propose general guidelines (and pitfall avoidance strategies) about parallel analyses, from the design stage through publication and beyond.

The design stage of a parallel analysis project is, unsurprisingly, crucial. The nature of the dataset(s) in particular bears substantial relevance to the project. Existing datasets convey advantages, particularly with respect to feasibility and planning. They also carry limitations related to recruitment and retention of analysts, as well as the relative suitability of different analysis strategies. The creation of a dataset bespoke to the project is advantageous, especially if a majority of analysts are recruited early and can participate in the specification of the datafiles. Given the cumulative effort required for such projects, we recommend choosing a journal and paper format prior to carrying out analyses, preferably using a pre-registration or two-phase review process, such as results-masked review. Calls for collaborators should state criteria for participation and should be distributed widely to attract diverse perspectives. The project should include a realistic and firm multistage agenda, standardized guidelines for reporting results (including artwork), and a clear plan for contrasting analyses and proposing best practice. Disseminating decisions should also include sharing open-source methods and data, where applicable, to the research community. Ultimately, we suggest that incorporating parallel analyses into BTS is an essential safeguard to a key risk inherent to big science: big mistakes (Forscher et al. 2023).

O.07.05 - Coordination dynamics meets active inference and artificial intelligence (CD + AI^2): A multi-pronged approach to understanding the emergence of sentient agency

Aliza Sloan [1], **Nancy Jones** [1], **Nynke Boiten** [2], **Karl Friston** [3], **Massoud Khodadadzadeh** [4], **Damien Coyle** [4], **Ja Scott Kelso** [5]

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Details

How do humans discover their ability to act on the world? We are investigating how goal-directed action emerges using young infants as a test field. By tethering a baby's foot to a mobile and measuring the motion of both in 3D (Fig. 1a), we explore how babies begin to make sense of their coordinative relationship with the world and realize their ability to make things happen (*N*= 16; mean age = 100.33

days). Machine and deep learning classification architectures (k-Nearest Neighbors, Linear Discriminant Analysis, Fully connected network, 1D- and 2D-Convolutional Neural Networks, 1D- & 2D-Capsule Networks) indicate that functionally connecting infants to a mobile via a tether influences the baby movement most where it matters, namely at the point of infant∼world connection (mean architecture accuracy = 74.11%, see Table 1) (Khodadadzadeh, et al., In Press). Using dynamics as a guide (Kelso, 2016; Kelso & Fuchs, 2016), we are developing tools to identify the moment an infant switches from spontaneous movement to intentional action (Fig. 1b). While a long history of developmental research anchored in reinforcement learning has demonstrated the role of positive feedback between infant and environment in infant learning, preliminary coordination dynamics analysis (Sloan, Jones, Kelso, 2023) and active inference generative modeling indicate that moments of stillness hold important epistemic value for young infants discovering their ability to change the world around them (Fig. 1c) (Friston, et al., 2017; Boiten, et al., In Prep). Finally, a model of slow~fast brain coordination dynamics based on a 3D extension of the Jirsa-Kelso Excitator (Jirsa & Kelso, 2005) successfully simulated the evolution of tethered foot activity as infants transition from spontaneous to ordered action. By tuning a small number of parameters, this model captures patterns of emergent goal-directed action (Fig. 1d). Meshing concepts, methods and tools of **A**ctive **I**nference, **A**rtificial **I**ntelligence and **C**oordination **D**ynamics at multiple levels of description, the **CD + AI^2** program of research aims to identify key control parameters that shift the infant system from spontaneous to intentional behavior. The potent combination of mathematical modeling and quantitative analysis along with empirical study allow us to express the emergence of agency in quantifiable, lawful terms.

O.07.06 - The development of tactile awareness: electrophysiological readout of perception-related responses in newborns and infants

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Details

The sense of touch is inherently linked to the conscious perception of ourselves, being a subjective and private feeling that pertains to our own body only. Thus, early somatosensory development has gained increasing research interest in cognitive neuroscience (Saby et al., *Int J Psychophysiol*, 2016). Previous studies nicely characterized the features of the electrophysiological signal evoked by tactile stimuli as a correlate of somatosensory processing early in life (Pihko et al., *Exp Neurol*, 2004). Yet, to our knowledge, whether the conscious perception of touch is organized and underpinned by neural patterns similar to those of adults in newborns and infants, remains unknown. Here, capitalizing on current knowledge about the correlates of tactile awareness in adults, we aim to describe their emergence through ontogenesis. Recently, by recording invasive intracranial EEG during somatosensory stimulation in adults, tonic late-latency responses localized in secondary somatosensory cortices have been identified as a reliable correlate of tactile awareness (Avanzini et al., *PNAS*, 2016). Leveraging the co-registration of intracranial and scalp EEG in adult individuals, we trained a machine learning algorithm, able to predict intracranial tonic responses based on scalp non-invasive EEG. By adopting such a cutting-edge methodology, we sought to measure a readout of tonic electrophysiological responses to touch

along the first months of life. To this aim, we recorded event-related potentials to median-nerve electric stimulation (SEPs) during wakefulness and sleep in 18 newborns (mean age=39.7 hours) and 18 infants (mean age=3.5 months). SEP results, paralleling previous developmental evidence, showed greater SEP amplitude in sleep than in wakefulness in both samples (newborns: F3 t=-3.34, p=0.003; infants: FC1 t=-3.71, p=0.002; Figure1A). To devise the feasibility of our algorithm in developmental data, we applied it to the SEPs recorded in an infant (age=97 days), who showed significantly greater tonic predicted responses during wakefulness than in sleep (Figure 1B). This result suggests an adult-like neural pattern, with tactile awareness correlates being greater in the vigilant than in the non-vigilant state, already at 3 months of age. We are now conducting these analyses on the whole developmental dataset, to determine whether tactile awareness is already organized in such a way at birth, or whether the adult-like pattern develops along the first months of life. Altogether, our results will represent the first-ever attempt to describe a correlate of tactile awareness early in life, characterizing its emergence. Given the central role of touch in early development (Cascio et al., *J Neurodev Disord*, 2010), the identification of early tactile awareness biomarkers will provide crucial knowledge to guide effective, targeted intervention in atypical developmental populations in which tactile awareness is impaired, such as autism spectrum disorder and attention deficit hyperactive disorder (Piccardi et al., *J Neurodev Disord*, 2021).

O.07.07 - Neuroadaptive Bayesian optimisation to study infants' engagement with social cues

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Details

Background

Infants' motivation to engage with the social world depends on the interplay between individual brain's characteristics and previous exposure to social cues such as the parent's smile or eye contact. Different hypotheses about why specific combinations of emotional expressions and gaze direction engage children have been tested with group-level approaches rather than focusing on individual differences in the social brain development. However, classic group-level inference approaches test whether stimuli manipulations produce mean differences in brain responses averaged across infants, effectively cancelling out individual differences in favour of group/condition differences. Here we applied a novel Artificial Intelligence-enhanced brain-imaging approach, Neuroadaptive Bayesian Optimisation, to infant electro-encephalography (EEG) to identify which combination of gaze direction and emotional expression of the parent's face produces the strongest brain activation in the individual child.

Methods

EEG data were acquired using the Enobio 8-channels EEG system (Neuroelectrics) from 37 6- to 9-month-old infants (M age = 7.21, SD = 1.03, 19 females) looking at images of their parent's face.

Combinations of the parents' faces displaying a range of emotional expressions and gaze directions were arranged in a 4 by 4 'search space' (Figure 1).

The Nc mean amplitude between 250 and 800 ms post-stimulus was calculated in real time after each block presenting one of the possible stimuli in the search space (12 trials per block). Subsequently, the Bayesian Optimisation algorithm selected the next stimulus to be presented based on the previous brain responses, with the aim to update the estimated function of the relationship between brain activation and the stimuli in the search space. For each tested infant, the experiment ended when algorithm identified the combination of gaze and emotion in the parent's face that maximised the Nc (optimum). The experiment and analyses were described in a registered report before data collection [embargoed].

We performed a Bayesian analysis to test whether infants generally preferred one quadrant of the stimulus space over the others. To compare the NBO results with the previous literature using a classic ERP design, we also tested whether there was a gaze (direct gaze vs 90 degrees averted) x emotion (very happy vs angry) effect on Nc mean amplitude.

Results

The algorithm successfully identified the optimal stimulus for thirty infants (81%) within on average 7.88 blocks (SD=1.93). For the majority of the children (43.33%) the stimulus that maximised the Nc amplitude was the very happy face with 90 degrees averted gaze (Figure 1). The Bayes Factor for the contingency table was 4.97, confirming that the happy-averted quadrant was generally preferred over the others. The classic ERP analyses revealed that there was a main effect of gaze ($F(1,26)=6.44$, $p=0.017$) and a significant gaze x emotion interaction ($F(1,26)=7.67$, $p=0.010$) with a more negative Nc, signalling enhanced engagement, for faces with averted gaze especially in the very happy condition (Figure 2).

Discussion

We found that most infants showed enhanced brain response to happy faces with averted gaze, possibly reflecting the emergence of joint attention. Planned work will investigate dimensional associations between the NBO responses and behavioural measures.

O.07.08 - From womb to world: tracking hand to mouth behavior from the fetus to the neonate

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Details

Human motor development originates with the fetus exploring the space around its body in the womb, but the developmental significance of the behaviors exhibited in the womb remains an open question.

The Perinatal Imaging Partnership with Families (PIPKIN, www.pipkinstudy.com) study investigates how variability in family context and fetal environment impact the emergence of intra- and inter-individual differences in infant behavioural and brain development, beginning in the third trimester. We examined associations between fetal spontaneous movements, measured via 4D ultrasound (US), and later newborn behaviour, measured via the Neonatal Behaviour Assessment Scale (NBAS).

NBAS motor and self-regulation total scores (n = 29) were rated by an NBAS observer at three home visits from the first 10 days of postnatal life, 11-20 days postnatal, and 20 to 47 days after birth. The kinematic properties of fetal motor activity identified as hand-to-mouth movements were recorded from 28 to 32 weeks gestational age (Scan I, n=29) and from the same participants at 33-38 weeks gestational age (Scan II, n=21). Kinematics were computed offline using three 60 second segments (selected from up to 5 minutes of fetal 4D US recordings) with distances between wrist and mouth calculated by a custom Python script using OpenCV tools (tinyurl.com/OpenCVfetal). Velocity was calculated as pixels displaced from movement onset to offset and regularized as a function of each frame's intra-ocular distance. Entropy was calculated as a function of velocity in addition to the number of attempted hand to mouth movements, duration of the movement from onset to target, and time to peak movement velocity. Generalized linear mixed-effects models examined how four criterion variables, *velocity* and *entropy* of fetal hand to mouth movements at Scan I and Scan II, accounted for the neonatal variation in hand to mouth movements (part of the self-regulation cluster) and motor maturity (part of the motor cluster).

Fetal wrist velocity was a significant predictor of neonatal variability in the *hand-to-mouth* NBAS item, with the effects driven by variation in NBAS scores at the earliest timepoints measured (2-10 days) and Scan I (28-32 weeks). The additional variance in fetal wrist velocity, as well as kinematic entropy, was required to predict variations in neonatal *self-regulation total score*, with this effect holding across timepoints, but again most significant between the earliest NBAS timepoint and US Scan I (figure 1). Fetal motor entropy was also a significant predictor of variability in neonatal *motormaturity* and *motor total scores*: these effects were primarily driven by NBAS scores at 1 month (20 days+) and its association with data from kinematic entropy measured at US Scan I or II (figure 2).

These findings are drawn from a perinatal cohort representative of the UK (household monthly income range = £1,400 – 8,000), ultimately in relation to 5-month outcome measures of cognitive, motor and neural development. Kinematic analysis will be extended to recordings of neonate behaviour and parent-child interactions. Kinematic markers of motor activity during the fetal period present a novel method to address continuity and change in the self-regulation and motor development across birth.

O.07.09 - Automatic infant motion extraction from videos: comparing six deep neural network pose estimation methods

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Details

To study how infants learn to reach, grasp, walk or, more generally, to investigate how infants develop numerous motor abilities, one needs to acquire accurate data about how infants move. Such data is also necessary to assess the risks of neuromotor impairments in early infancy. The golden standard is to use a marker-based motion capture system. However, such systems can mainly be used in laboratory settings by specialists. This, in turn, can limit the number of infants that can be recorded, the duration of data acquisition or the diversity of conditions under study.

Over the past decade, alternative pose estimation methods with only standard video input have been developed. They provide coordinates of specific parts of the body (keypoints - for example, the eyes, wrists, hips, feet). These methods were primarily developed to detect and extract body postures of adults. Infant body morphology is different from adults, especially in early infancy. Additionally, infants are often in supine position, which is not represented in the image datasets used for training these methods. The suitability of such methods for the study of infant motion has yet been thoroughly evaluated.

In a previous study (Khoury et al., ICDL 2022) to find developmental patterns in infant spontaneous movements, we encountered some limitations of current pose estimation methods. Some examples are shown in Fig.1.

We compared the performance of infant pose estimation of six 2D pose estimation methods.
We used two datasets with ground-truth position of body parts: (i) "synthetic infants'' (Hesse, 2018) with 12 motion sequences obtained from infants aged up to 7 months and lying supine; (ii) we manually annotated a subset of images from video recordings of infants aged 8 to 25 weeks. We used standard indicators that evaluate how close the output of pose estimation matches the ground truth data, such as Average Precision and Recall. We supplemented this comparison with other indicators (seven in total), such as an error relative to the length of the torso of the infant (see Fig.2).

We found that, surprisingly, most methods trained on adult data perform well on infant images without additional training. The performance of the well-performing networks was lower for the legs than for other body parts. ViTPose was the best performing method; AlphaPose and OpenPose had the highest ratio of missing detections. AlphaPose was running the fastest making it the best suited for real-time applications. DeepLabCut performed the worst by a large margin, restricted by its internal old pose estimation method (DeeperCut).
We make the tested methods available through an online public repository (Docker image).

O.07.10 - Neuroadaptive Optimisation reveals group-level null-effect of familiarity preference as heterogeneous individual preferences

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Details

Face recognition plays a critical role in early social development. While neural attention correlates to familiar vs novel faces increase in the first six months, this difference often does not appear in later infancy; similar patterns have been observed in autistic toddlers. Traditional group paradigms cannot disentangle whether these 'null' findings stem from a lack of robust attentional preferences, whether infants prefer a more 'average' face template, or whether there are attentional preferences varying in their direction between infants. In this proof-of-principle study, we used a novel, individualised closed-loop experimental design, Neuroadaptive Bayesian Optimization (NBO), to study in individual infants how neural responses map onto faces linearly varying in similarity to parent's face.

Sixty-one infants (5-12 months) were presented with face images resulting from morphing their caregiver's face into a stranger's face and ordered along a familiarity-continuum (*Figure 1*). EEG was streamed from 6 fronto-central channels using the wireless ENOBIO system (NE Neurolectrics) and Lab Streaming Layer. After 12 trials x 500ms repeatedly presenting one face, the Negative central (Nc) mean amplitude for this face was calculated and fed into a Gaussian process model of the individual's response function across the familiarity-continuum. The algorithm selected the next stimulus, aiming to maximise the Nc amplitude. The loop stopped upon repeated sampling of the same stimulus, considered as identification of the optimal stimulus ("convergence"). We calculated for each infant the optimum-parent distance and related it to age and parent-reported infant social behaviour. We also investigated the Nc to original parent and stranger face both across the sample, and within subsample of infants converging on the parent and stranger continuum-side, respectively. This study was preregistered on OSF: DOI:10.17605/OSF.IO/CWF96.

Of 52 infants completing the experiment, in 44 the optimum was identified, after M=10.34 blocks (SD=2.26, range: 6-14). The optimum-parent-distance was not related to age (β = -0.004, *SE* = 0.002, *p* = 0.721 *p* = 0.157), or parent-reported infant social behaviour (all *p*>0.3). Including parent-stranger-similarity did not change the pattern of results. The group-level Nc to original images did not differ between conditions ($F(1,42) = 0.63$, $p = 0.43$, $\eta_p^2 = 0.01$), age group (5-to-8 vs 9-to-12 month-olds, $F(1,42) = 0.22$, $p = 0.64$, $\eta_p^2 = 0.01$) and their interaction ($F(1,42) = 0.83$, $p = 0.37$, $\eta_p^2 = 0.02$). The subgroup of infants converging at the parent side (n=24) showed a stronger Nc for parent vs. stranger ($F(1,23) = 15.39$, $p < 0.001$, $\eta_p^2 = .40$), while infants converging at the stranger side (n=20) showed a stronger Nc for stranger vs. parent ($F(1,19) = 30.39$, $p < 0.001$, $\eta_p^2 = .62$, *Figure 2*).

This study combined NBO with low-density infant EEG to predict the individual's Nc response across the familiarity-continuum. Consistency between subsample-results and individual-level results indicate robustness of the latter. Besides its practical utility through increased efficiency and lower attrition, NBO could show that the group-level null-effect for parent-vs-stranger-preferences in middle infancy reflects heterogeneous individual preferences instead of intermediate or no preference. Individual optima were unrelated to age and social behaviour in this sample.

O.07.11 - Maternal touch and its relation to the infant's affective and discriminative brain responses: an fNIRS study

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Details

Tactile experience is an important modality in mother-infant interaction, in particular in the first year. Touch promotes infant development and fosters the quality of the mother-infant relationship.

A major distinction in neurophysiological studies of tactile experiences is between discriminative touch and affective touch. Studies in healthy adults have shown that discriminative touch primarily activates the somatosensory cortex (SS), while affective touch also recruits several areas in the "social brain" network, including the posterior superior temporal sulcus (pSTS). Less is known in infancy regarding the neurodevelopment of areas related to processing touch and how they correlate with the frequency of touch.

Thus, this study aimed to investigate whether early caregiving experiences, specifically the frequency of maternal touch, measured at 7 and 12 months in a free play task, are associated with infants' cortical responses to affective and discriminative touch. Infants were tested at both age points, with an experimenter applying two touch stimuli—a watercolor brush for affective touch and a wooden cube for discriminative touch— in the infant's forearm while the infants watched a silent movie.The changes in both oxy-hemoglobin (HbO2) and deoxy-hemoglobin (Hbb) were recorded through functional near-infrared spectroscopy (fNIRS); we only report the HbO2 findings. The fNIRS array utilized a montage with two areas of interest: the left somatosensory region and the right posterior superior temporal sulcus. Baseline-corrected activation to discriminative and affective touch served as the dependent measure. Additionally, both mother and infant engaged in a free-play without objects task at both age points. Maternal touch events during the interaction were segmented, and the total proportion of interaction time with maternal touch was derived from the touch event data.

Utilizing a linear mixed model we measured the if the proportion of interaction time with maternal touch (a proxy to early infant touch experiences) was a predictor of the fNIRS activation, beyond what can be explained by the experimental factor (discriminative vs. affective).

Our findings at 7 months revealed that infants of mothers who touched more exhibited decreased activation in the somatosensory cortex, specifically when exposed to affective touch. In contrast, infants of mothers who touched more displayed heightened activation in the Superior Temporal Sulcus (STS) for both affective and discriminative touch. However, by the time the infants reached 12 months, a shift in the relationship between maternal touch and hemodynamic response to affective and discriminative touch emerged. In the STS, infants of mothers who provided higher levels of touch exhibited increased activation in response to affective touch, although no discernible trend was observed for discriminative touch. Conversely, in the somatosensory cortex, infants of mothers offering increased touch showed no detectable slope in response to affective touch but decreased responses to discriminative touch. A complete visualization of these results can be observed in Figure 1.

Together, these results support that the infant's touch experiences have a role in modulating the infant's brain responses to both affective and discriminative touch.

O.08: Parenting

O.08.01 - Maternal responsiveness to infant distress among U.S. immigrant families

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Details

Infants the world over express distress when they have a need to be met by their caregiver. Mothers' abilities to respond appropriately and contingently to her infant have repercussions for her infant's social and emotional development (Markova & Legerstee, 2006). However, maternal responses to infant distress are affected both by cultural background (e.g., the extent to which mothers speak to their infants) and biological constraints (e.g., the infants' need to be fed and have other physical needs met) (Bornstein et al., 2017). Additionally, maternal responsiveness varies with immigration experience (Bornstein & Cote, 2019). This study investigated how maternal responsiveness to infant distress is modified by the acculturation process for immigrant mothers and explored sequelae of maternal responsiveness for infant development. Ward's culture learning perspective motivated the present study of the acculturation of responsiveness (Masgoret & Ward, 2012). This perspective investigates' immigrants' behavioral adaptation for behaviors that are known to differ between the immigrants' culture of origin and destination. The acculturation of maternal responsiveness was examined at both group and individual levels (Berry, 1987). Methodologically, group-level acculturation was assessed in immigrant Japanese, South Korean, and South American dyads in comparison with nonmigrant dyads in their respective cultures of origin (Japan, South Korea, and South America) and destination (United States). Pearson correlations assessed acculturation at the individual level. Regression analyses examined sequalae of maternal responsiveness for infant development.
408 5½-month-old infants were observed with their mothers in naturalistic interactions at home. A maternal response was considered contingent when it occurred within 5 sec of the onset of infant cry during dyadic interactions (Bornstein et al., 2017; Van Egeren et al., 2001). The frequency of five maternal responses to infant distress were explored: holding their infant, talking to their infant, displaying affection, distracting with an object or toy, and providing physical care/nurturing. Mixed design MANOVAs explored mean differences in responsiveness at the group level and differences in

patterns of responsiveness (Table 1). Results indicated that Japanese immigrant mothers spoke to their infants less in response to infant cries than either Japanese or European American mothers, and Japanese immigrant mothers engaged in less positive affect in response to infant cries than mothers in Japan. No group-level acculturation differences were found for Korean immigrant dyads. South American immigrant mothers responded to infant cries by speaking, holding, showing positive affect, and distracting their infants less than either Argentine or European American mothers. Across cultural groups, mothers were more likely to respond to infant cries by vocalizing than with any other behavior (i.e., holding, nurturing, positive affect, distracting). No significant individual-level acculturation effects were found. Maternal responsiveness showed differential effects on infant development across immigrant dyads.
In this study, acculturation of maternal responsiveness was more apparent at the group than individual levels, and differences among immigrant groups in acculturation were apparent. These results further our understanding of the ways immigrant mothers' parenting responses acculturate and influence infant development for infants in immigrant families.

O.08.02 - The development of emotion labeling from infancy to kindergarten

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Details

Children's emotion categories emerge in infancy and continue to diversify across development (Widen, 2013). However, how children learn emotion labels and the potential downstream influence of parent emotion socialization during infancy on children's later emotion labeling remain understudied.

This study of 296 children (139 girls) explored changes and links in children's and parents' emotion labels from infancy to kindergarten. Parent-child dyads were recorded annually for 4 years starting when children were infants (2-to-3 years old, M = 2.44 years, SD = .26) discussing a wordless picture book depicting a character expressing an emotion (i.e., Joy, Anger, Fear, Sadness, or Disgust; see Figure) in response to an elicitor (e.g., dropping ice cream). Conversations were transcribed and whether parents and children provided emotion labels matching the intended emotion were coded from transcriptions.

We first examined mean differences in the proportion of parents and children who provided correct emotion labels using separate repeated-measures GLMMs with a binomial distribution and a logit link. Parents' emotion labels differed by emotion, F = 97.20, p < .001, but remained consistent across wave (p = .14). Most parents provided correct labels on pages depicting joy, sadness, fear, and anger, but only a minority provided a correct label for disgust (see Table).

Children's correct emotion labeling increased with age but depended on emotion, F = 2.18, p = .01. Specifically, children's correct joy, sadness, and fear labeling remained stable at the 2.5-year and 3.5-year waves but increased significantly at the 4.5-year and 5.5-year waves compared to the 2.5-year wave (see Table). There was a significant increase in children's correct anger labeling from the 2.5-year

wave to the 3.5-, 4.5-, and 5.5-year waves. Children's correct disgust labeling remained consistently low at all waves.

We next examined relations between parent and child correct emotion labeling from infancy to kindergarten using multigroup (i.e., multi-emotion) cross-lagged path analysis. An unconstrained model relating parents' and children's emotion labels to each other across waves demonstrated superior model fit compared to a model constraining model pathways between emotions to be equal, X^2 (420) = 603.24, $p < .001$; RMSEA = .038; CFI = .94, SRMR = .036. Results showed different within-wave and across-wave relations between parent and child emotion labeling depending on discrete emotion. Additionally, parent sadness labeling during infancy positively predicted children's sadness emotion labeling at 5.5 years ($b = .25$, $p < .05$), and parent joy labeling predicting child joy labeling at 4.5 years ($b = .17$, $p < .05$).

Taken together, these results highlight different developmental trajectories for children's discrete emotion labels and the differential role of parent emotion labeling depending on emotion. To our knowledge, this is the first comprehensive longitudinal study linking changes in children's emotion labeling to parent emotion labeling across infancy and into the school years. Implications for children's emotional development and emotion socialization will be discussed.

O.08.03 - Co-parenting, mothers' sleep quality, and infants' socio-emotional adjustment

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Details

Infant socio-emotional development is multiply determined and influenced by a variety of factors embedded in the infant's broader social ecology (Sadeh et al, 2009). The present study examines two such factors, quality of coparenting and maternal sleep quality. Although studies exist on the putative impact of quality of coparenting on infants' socio-emotional adjustment (LeRoy et al., 2013), little is known about whether the extent of coparenting's effects depend on the quality of mothers' sleep. We consider this question to be important, given recent work indicating that sleep in mothers is directly related to quality of parenting and adult functioning in a variety of domains (Bai et al., 2022).

The present study examined the moderating effect of mothers' sleep quality on the relationship between the quality of the coparenting relationship and children's socio-emotional adjustment by 24 months. It was predicted that there will be a direct effect of the quality of the coparenting relationship in the first year and the development of adjustment problems in the second year, with poor coparenting relationship quality predicting increased adjustment problems. Additionally, it was predicted that the direct effect between coparenting relationship quality and adjustment problems will be moderated by mothers' sleep quality such that the negative effect of poor coparenting on children's socio-emotional adjustment will be mitigated when mothers get better sleep.

Data were obtained from 167 parents with infants across the first 24 months of the infants' life. At 6, 9 and 12 months, parents independently completed the Coparenting Relationship Scale (Feinberg et al., 2012). The scale was utilized to measure their perceptions of the coparenting relationship. At 18 and 24

months, parents completed the Infant Toddler Social and Emotional Assessment (ITSEA) Questionnaire (Carter and Briggs-Gowan, 2006).

The ITSEA was used to assess the broad range of socio-emotional and behavioral problems between 18 and 24 months. Lastly, data on the quality of mothers' sleep was measured via their sleep wake activity. Mothers wore ACTiwatches continuously over a seven-day period and the mean of their measures on sleep quality markers of fragmentation, efficiency, wake minutes and sleep percentage assessed.

Linear regression analysis revealed positive coparenting was negatively linked with externalizing behavior and dysregulation, and negative coparenting was positively related with both externalizing behavior and dysregulation. Similar results were not found for internalizing behavior. Adding sleep quality variables as a moderator, results indicated that all markers of sleep quality reviewed moderated the relationship between the coparenting relationship and children's socio-emotional adjustment such that the link between negative coparenting and infant internalizing behavior was lower among mothers who had good quality sleep, compared to mothers who had poor quality sleep. Similar results were found with positive coparenting on all sleep quality markers except fragmentation. Comparable results were not found for externalizing behavior nor dysregulation.

The findings indicate a dual protection of quality sleep for mothers and good coparenting relationship on internalizing behavior of infants (See Figures 1 &2). Additional analysis will explore using latent profiles, the combination of proximal and distal factors that influence socio-emotional adjustment.

O.08.04 - Cross-lagged associations between maternal beliefs about crying and child temperament: The role of parity

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Details

Mother-oriented beliefs about crying are centered around mother's own concerns rather than the infant's needs, and as a result are associated with lower sensitivity to infant distress (Leerkes et al., 2015). Maternal perceptions of infant negative emotionality also predict parenting cognitions and maternal sensitivity (Paulssen-Hoogeboom et al., 2007). The extent to which beliefs about crying and perceptions of infant negative emotionality influence one another over time is less clear, and such knowledge has both applied and methodological implications. Thus, we examine cross-lagged associations between two beliefs, minimization and spoiling, and perceived infant negative emotionality and examine parity status as a moderator. We anticipated that cross-lagged associations would be stronger among first time mothers whose beliefs and perceptions have not been influenced by characteristics of older children or prior parenting experience.

The sample included 299 mothers (125 primiparous, 174 multiparous) and their infants (48.8% female). Mothers reported their age and education and their beliefs via the Infant Crying Questionnaire (ICQ; Haltigan et al., 2012) during their third trimester. We focused on two subscales: minimization (e.g., think baby just wants attention) and spoiling (e.g., how I respond could spoil baby). When infants were 2, 6

and 14 months old, mothers completed the ICQ again and rated infant negative emotionality via the Infant Behavior Questionnaire- Very Short Form (Putnam et al., 2014).

Two cross-lagged path models were computed in Mplus, one with minimizing and one with spoiling beliefs, each followed by multigroup comparisons between primiparous and multiparous mothers. Maternal age and education were time invariant covariates. As illustrated in Figures 1 and 2, there is significant stability for both maternal beliefs about crying and negative emotionality, few significant within-time associations (2 months for minimization and 14 months for spoiling), and no cross-lagged effects for the sample as a whole. The multi-group analysis for spoiling and negative emotionality was not significant ($\chi^2(10) = 3.96$, $p = .95$), but it was statistically significant for the minimization model ($\chi^2(10) = 27.62$, $p = .002$). Specifically, the pathway from prenatal minimization to negative infant emotionality at 2 months ($\chi^2(1) = 7.29$, $p = .01$) varied (bold path in Figure 1). Only primiparous mothers with higher minimization beliefs about crying prenatally reported higher negative emotionality at 2 months.

When considering the sample as a whole, there were no cross-lag effects, reducing concerns that maternal beliefs bias perceptions of temperament and suggesting perceptions of temperament do not shape beliefs about crying. However, new mothers who likely have little experience with infant crying and believe infant crying should be minimized may be particularly reactive to infant crying in the early postpartum and over-rate infant negative emotionality as a result, which could have long-term effects on the perceptions of their infants, given stability over time. No such effect was apparent for spoiling. Given the significant correlation between concurrent spoiling beliefs and negative emotionality at 14 months, a period when autonomy struggles begin, it may be useful to examine possible cross-lagged effects into the third year of life.

O.08.05 - Unpredictability of maternal sensory signals and maternal childhood maltreatment are associated with infant negative emotional reactivity – a study from southwestern Uganda

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Details

Abstract

Background
Women in low- and middle-income countries (LMIC) are at heightened risk of experiencing childhood maltreatment, with potential consequences for their offspring. Recent research, mostly conducted in high-income western nations, underscores the role of maternal parenting behavior as a mediating

pathway between maternal exposure to childhood maltreatment and child development. This study extends this research into the LMIC context by examining whether maternal unpredictability, a novel marker of maternal sensory signals, mediates the link between maternal childhood maltreatment and infant emotional reactivity in Ugandan mother-infant pairs.

Methods

The study involved 115 mother-infant dyads from southwestern Uganda. Maternal childhood maltreatment was quantified through self-reports using the Childhood Trauma Questionnaire. Unpredictability of maternal sensory signals was evaluated through an entropy rate analysis, assessing the predictability of maternal sensory signal transitions during free play interactions with their 7-9-month-old infants. Infant negative emotional reactivity during the Still Face paradigm was assessed using a micro-level coding system. Observed negative affect duration, intensity, and latency were highly correlated and aggregated into a composite measure of infant negative emotional reactivity.

Results

Moderate to extreme levels of maternal childhood maltreatment were highly prevalent (43.5%) in our sample. Both maternal childhood trauma exposure (b = -.300; p = .008) and maternal unpredictability (b = -.857, p = .018) were independently associated with reduced infant negative emotional reactivity. However, the association between maternal childhood maltreatment and infant negative emotional reactivity was not mediated by maternal unpredictability.

Conclusions

The current study contributes to the understanding of intergenerational transmission pathways associated with maternal childhood maltreatment by examining maternal unpredictability as a potential transmission mechanism influencing early emotional development. By investigating a sample from southwestern Uganda, characterized by a high prevalence of childhood maltreatment, our study extends the scope to majority world settings that have often been understudied.

O.08.06 - Mother-infant self- and interactive contingency at four months and infant cognition at one year: A view from microanalysis

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Details

Method

A community sample of mothers (N=100), self-identified as largely Latina, living in lower-SES, lower education contexts, and enrolled in a longitudinal prospective birth cohort, participated in lab split-screen videotaping. Mothers playing with their 4-month infants “as they would at home” (without toys), were coded on a 1s time-base (by coders blind to Bayley-status) for mothers and infants separately: positive-to-negative mother and infant facial affect, infant vocal affect, mother touch, and mother and infant gaze-on/off partner (Cohen’s kappa ≥.70). Infant cognition was assessed at

one year by the Bayley Scales of Infant Development (3rd Edition 2006), Mental Development Index (MDI), representing overall cognitive ability.

Multi-level time-series models quantified predictability of second-by-second behavior within individuals (self-contingency [auto-correlation]) and between individuals (interactive contingency [lagged cross-correlation]). R software estimated random and fixed effects on the pattern of self- and interactive behavior over 150 sec, using weighted-lag time-series models (prior 3s of behavior predicting behavior at t_0). Estimated coefficients of one form of contingency controlled for the other. We tested associations of 4-month contingency with 12-month MDI (as continuous variable) for 7 interpersonal modality-pairings (see Table 1), controlling for infant gender and mother age (other covariates NS).

Individual-seconds time-series models and predicted values at t_0 for higher (vs. lower) MDI groups interrogated significant weighted-lag findings. Predicted values analysis for individual-seconds models required 2 groups: a Higher-MDI (116+) group, N=28; and a Lower-MDI group. Predicted values explication identified patterns of behavioral predictors across the prior 3s that most contributed to higher- vs. lower-MDI group differences at t_0.

Results

Infant and mother 4-month self-contingency, the moment-to-moment probability that the individual's prior behavior predicts the individual's current behavior, was the measure most associated with 12-month infant MDI. More varying infant self-contingency was associated with higher infant MDI, specifically greater modulation of negative affect; more stable maternal self-contingency was associated with higher infant MDI, specifically greater likelihood of sustaining positive facial affect. Interactive contingency findings were sparse but showed that, when mothers looked away, or dampened their faces to interest/mild-negative facial affect, infants who were less likely to show negative vocal affect at 4 months had higher 12-month MDI.

Discussion

Infant ability to modulate negative affect, and maternal ability to sustain positive affect, may be mutually reinforcing, together creating a dyadic climate that is optimal for infant cognitive development. These 4-month patterns potentially organize infants' developing procedural expectancies of the ways that interactions proceed, affecting the trajectory of cognitive development.

O.08.07 - Black mothers' and fathers' experiences with racism in the United States: associations with parents' childrearing attitudes in infancy

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Details

Parental beliefs and attitudes about childrearing play an important role in shaping caregiving practices beginning in early infancy (Sigel & McGillicuddy-DeLisi, 2002), with implications for infant-parent

attachment and healthy development in the early years (e.g., Brown & Cox, 2020). Recent attention has been devoted to developing more culturally specific models of childrearing. Specifically, racial and ethnic minority families in the United States may develop parenting beliefs and practices that reflect both historical and current demands of oppression, discrimination, and racism (Coard, 2022). However, research on links between parental experiences with racism and parents' childrearing attitudes are still very limited, and the existing research has focused exclusively on older children and not infants (e.g., Nelson et al., 2012). We attempted to address this gap by examining associations between Black mothers' and fathers' experiences with racism in the United States and their childrearing attitudes towards their infants.

Participants were 190 unmarried, Black mothers and fathers residing in rural areas in a Southern state in the U.S. When infants were 3-6 months old, mothers and fathers completed surveys that included measures on their experiences with racism and their childrearing attitudes. Experiences with racism was assessed using a 9-item measure assessing frequency of instances of individual racism or racial discrimination (Harrell, 2000). Childrearing attitudes were assessed using the Nurturance (e.g., 'I generally like to keep my baby as close as possible to me' and Discipline (e.g., 'it is never too young to start disciplining a child') subscales of the Infant Parenting Questionnaire (Arnott & Brown, 2013). Additionally, parents completed the Childrearing Attitudes questionnaire (developed for this study), which measured both independence (e.g., 'My child should learn to be tough') and security (e.g.,' My child should feel safe and secure.').

A path model was tested to assess maternal and paternal experiences with racism as predictors of their childrearing attitudes (i.e., nurturance, discipline, independence, and security). Correlations for all study variables are reported in Table 1. Results showed divergent patterns for mothers and fathers. Maternal (but not paternal) experiences with racism were associated with stronger parenting attitudes prioritizing infants' security, whereas paternal experiences with racism (but not maternal experiences) were positively associated with childrearing attitudes promoting discipline and independence, and negatively associated with attitudes toward nurturance (see Figure 1).

Taken together, findings suggest that mothers' experiences with racism may result in a greater desire to protect and keep their infants safe, whereas fathers' experiences with racism may contribute to fathers believing that infants require more independence and discipline and less nurturance, perhaps in preparation for coping with racism. Findings are broadly consistent with Paquette's (2004) model positing that mothers play a greater role in promoting children's safety and security whereas fathers playing a greater role in promoting independence and autonomy. Further, results suggest that experiences of racism may differentially impact maternal and paternal attitudes towards childrearing in early infancy, which in turn may impact their caregiving behaviors and infant outcomes. Subsequent analyses will examine links between racism, parental beliefs, observed caregiving behaviors, and infant socioemotional outcomes.

O.08.08 - Effects of prenatal maternal psychological risk and early caregiving on profiles of infant temperament

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Details

Infant temperament (e.g., surgency, negativity) is biologically-based and marked by individual differences in reactivity and self-regulation (Gartstein & Rothbart, 2003), and is evidenced to predict subsequent developmental outcomes (Padilla et al., 2020). Prenatal maternal stress is believed to influence infant temperament via fetal programming, in which maternal stress hormones produced by the hypothalamic-pituitary-adrenal axis adversely affect fetal development through placental functioning (Takegata et al., 2021). In addition, early maternal sensitive responses to infant cues may alter temperament largely by affecting neonates' ability to self-regulate (Putnam et al., 2002; Rothbart et al., 2004). Individual differences in temperament are often assessed via maternal report or direct observation of infant affect and physiological indices of regulation, including respiratory sinus arrhythmia (RSA). Higher baseline RSA reflects "easy" temperament, RSA withdrawal to challenge reflects active regulation, and RSA recovery post challenge reflects efficiency or efficacy of regulation (Calkins, 1997; Perry et al., 2018). Recently, person-centered approaches have been applied to identify infants with distinct temperament profiles across multiple indicators assessed during the Still Face Paradigm (Hipwell et al., 2019; observed positive and negative affect; Qu & Leerkes, 2018; observed negative affect and RSA). However, no studies have examined temperament profiles with concurrent indicators of both mother-reported and observed positive and negative affect and RSA. In the current study, we identify (a) profiles of infant temperament captured by multiple methods, and (b) the role of prenatal psychological risk and maternal sensitivity in differentiating the profiles focusing both on main effects of each and their possible interactions.

Participants were 299 mothers (42.7% non-White) and their 2-month-old infants (51.2% males). During their third trimester, mothers reported current psychological stressors (stressful life events, depressive and trait anxiety symptoms, relationship hostility) and demographics. When their infants were 2 months old, mothers reported their perceptions of infant surgency and negativity. Infant positive and negative affect and maternal sensitivity were rated during a free-play task and the Still-Face paradigm and infant heart rate was recorded to compute RSA (Porges, 1985). Covariates included maternal age, parity, infant gestational age and age during visit, and maternal depressive and anxiety symptoms at 2 months. All analyses were conducted in Mplus.

Three profiles were identified (Figure 1): high negative affect with physiological recovery (profile 1; n = 62, 23.3%), high negative affect with no physiological recovery (profile 2; n = 17, 6.4%), and low negative affect with physiological recovery (profile 3; n = 187, 70.3%). Profile 3 appeared to show the most adaptive pattern of infant temperament whereas profile 2 represents the least adaptive pattern. Further, when profile 3 was the reference group, infants of mothers with higher maternal sensitivity

were less likely to be in either profile 1 (OR = .093, 95% CI [.029, .298]) or 2 (OR = .072, 95% CI [.017, .305]). However, no significant main or interactive effects involving maternal prenatal psychological stress were found to differentiate the three profiles. Results suggest a more significant effect of early sensitive caregiving than prenatal stress on early infant temperament profiles.

O.08.09 - Caregiver proximity and holding, not vocalizations, support real-time vagal regulation

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Details

Caregivers play a critical role in infant physiological regulation. Lab-based studies show that more responsive mothers have infants that are better regulators, indexed by a decrease in respiratory sinus arrhythmia (RSA) during standardized stressors (Jones-Mason et al., 2018). However, little is known about the specific behavioral mechanisms that lead to in-the-moment physiological regulation in naturalistic settings.

N=71 infants and their caregivers wore a Move4 ECG/accelerometer on their chest and were videotaped in their home going through a series of structured and unstructured tasks for 60 minutes. Infants were 48% non-Hispanic White and on average 4.5 months old (SD=2.5, Range=0.9-10.8mo). Infant distress was annotated from video by trained research assistants (ICC=0.85). Infant crying and fussing within 5 seconds were combined into a single “distress” category (Hubbard & Van IJzendoorn, 1991). N=41 infants (58%) had at least one distress episode recorded. Research assistants also annotated caregiver regulatory behaviors, including vocalizations (ICC=0.75) and two proximity annotations: within reach and holding (ICC=0.84). R-R intervals were extracted using Movisens DataAnalyzer and artifacts were removed using KubiosHRV. A 15-second sliding window (updated every 200 ms) of RSA values was computed to obtain a dynamic RSA timeseries for analysis (Abney et al., 2021). To isolate the effect of regulatory behaviors on RSA in the context of infant distress, we calculated an event-related potential (ERP) analysis for the first instance of each regulatory behavior of interest (caregiver picking up and holding, caregiver moving closer, caregiver vocalization) that started after infant distress onset and before distress offset.

For N=140 distress episodes across N=41 infants, after the distress episode started, caregivers responded to 72% by vocalizing to the infant (n=101), 28% by picking up and holding the infant (n=39), and 6% by moving within reach of the infant without picking up and holding the infant (n=8). While most distress episodes led to a response within 10 seconds (median=9.44s), some latencies were upwards of 2 minutes (range=0.03-204.50s; Figure 1). We found that caregivers moving within reach and holding their infant, but not vocalizing, produced significant decreases in infant RSA (Figure 2), consistent with the hypothesis that caregivers scaffold decreases in infant RSA that allow for coping (Ostlund et al., 2017). Additionally, when a caregiver moved within reach or picked up their infant, this produced a significant time-locked decrease in caregiver RSA, possibly reflecting their active engagement in soothing their infant (Leerkes et al., 2016).

This study provides the first direct hypothesis test that caregiver regulatory behaviors produce time-locked changes in RSA. Our study leverages observations from naturalistic infant distress in the home, affording us access to ecologically valid variability in the types and latencies of caregiving responses to distress. We found response latencies to vary widely and be much longer on average than the 3-5s latencies observed in traditional laboratory settings (van Egeren et al., 2001). Additionally, our findings suggest that caregiver proximity and holding produce short, reliable decreases in infant and caregiver RSA, indicating one pathway by which parenting behaviors actively shape physiological arousal and regulation "in the wild."

O.08.10 - Motor affordances in low-income families relate to infant motor skills acquisition

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Details

Infant motor development is an epigenetic process by which caregivers update their expectations and behaviors to meet the demands of infants' changing skills. New motor skills, in turn, create learning opportunities for infants to explore, navigate, and interact with an expanding physical and social environment (Anderson et al., 2013; Adolph et al., 2009). Thus, understanding the ecology of motor development, including but not limited to auditory, motor, social environments at home is important for helping us to better appreciate the diversity and variability in the process of motor skill acquisition and the contributing role of specific experiential factors. Among all experiential factors, parents play a significant role in constructing the learning environment, providing motor affordances for infants (Gibson & Schumuckler, 1989). However, this relation is hardly studied in infants, especially in low-income, ethnically minoritized families. This study aims to document the motor affordances in this population and explore the associations between motor affordances and motor skill acquisition.

This study used rich interview and observation data from 100 low-income fathers and mothers in the U.S. (household income < $70,000; 60% Hispanic, 20% Black, 8% White, 12% Other) drawn from a larger NICHD-funded longitudinal intervention study (Cabrera & Reich, 2017). Our study documented the variation in infants' motor skill acquisition, routine physical activity provided by both mothers and fathers and further examined how mothers and fathers each contribute to the trajectories of infant motor development. Both parents were interviewed when the infant turned 9 months and 18 months respectively and reported the type and frequency of a variety of physical activity in which they engaged their infant. When the infant turned 21 months, the primary caregiver was interviewed again about the ages (in months) at which the infant acquired specific motor skills such as crawling, standing, and walking. Parents reported high level of confidence (8.2/10, *SD* = 1.42) in retrieving these motoric milestones.

Preliminary results from this economically and ethnically diverse sample showed: (1) the majority of caregivers reported that their infants skipped belly crawling (56%), a common mode to start prone progression, and started walking independently at about 13 months; (2) earlier acquisition of locomotive skills such as standing transferred to later locomotive skills such as walking; (3) low-income fathers and mothers did not differ in the total amount of physical activities they engage their child. However, fathers

were significantly more engaged in gross motor activity than mothers, and (4) paternal reports of physical activity were significantly associated with the onset of walking whereas maternal reports of physical activity were significantly associated with the onset of standing. The associations between each type of physical activity and motor skills, as well as other parenting- and family-level factors such as childcare arrangements, media use, and coparenting support in the low-income families will be discussed in the oral presentation.

Taken together, these findings have implications for understanding the variation and dynamics in motor development in infants, as well as fathers' and mothers' roles in motor skill acquisition.

O.08.11 - Unraveling the dynamics: examining marital conflict and child temperament using an autoregressive cross-lagged panel model

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Details

Exploring the bidirectional link between marital conflict and child temperament is important in developmental psychology. Specifically, marital dynamics have been found to significantly influence the interplay between child temperament and the emergence of behavioral issues in children[1]. Evidence suggests that marital conflict correlates with young children exhibiting more relational aggression[2]. Furthermore, children from families experiencing frequent conflicts are more likely to face interpersonal difficulties later in life[3] compared to those from more harmonious homes, who typically show fewer behavioral problems and improved well-being over time[4–8]. However, the directionality of these influences—whether marital conflict shapes child temperament or vice versa—is less understood, particularly from a longitudinal perspective. This study examines this interplay longitudinally with an at-risk sample with the hope of understanding the relationship between marital conflict and child temperament to allow for more precise, targeted intervention.

This study used data from a larger project that consisted of a sample of 895 low-income families residing in Toronto, Canada. Recruitment and data collection took place from 2015–2021. Data were collected at three time points during infancy (M = 1.23, SD = 0.25), toddlerhood (M = 2.73, SD = 0.23), and preschool (M = 4.68, SD = 0.69). The sample consists of participants from diverse demographic backgrounds (average household income $40,000–$49,999, well below the average income in Toronto[9]; 71% non-white; 55% mothers above Bachelor). Marital conflict was measured using the Conflicts and Problems Scale (CPS),[10] in which parents were asked to indicate the frequency and severity of their conflicts. Child temperament was measured using the Infant Behavior Questionnaire (IBQ)[11], the Early Childhood Behavior Questionnaire (ECBQ)[12], and the Children's Behavior Questionnaire (CBQ)[13]. Since all data were collected at three time points, an autoregressive cross-lagged panel model was conducted to study the longitudinal relationship between marital conflict and child temperament.

The final sample consisted of 392 families. The model revealed significant associations between marital conflict and child temperament across time (Figures 1 & 2). Specifically, early evidence of marital conflict (Time 1) was associated with an increase in anger in children at a subsequent time point (Time 2; b = .18,

SE = .07, *p* = .009), but not vice versa. Meanwhile, marital conflict and anger in children are also found to be correlated at Time 1 (σ = .19, *SE* = .07, *p* = .005) and Time 3 (σ = .16, *SE* = .07, *p* = .03). While marital conflict is not correlated with fear in children at all time points, children who expressed more fear at Time 2 had parents who experienced an increase in marital conflict at Time 3 (b = .15, *SE* = .06, *p* = .02), without evidence of a reciprocal effect. These findings further affirm the dynamic and reciprocal nature of family interactions[2–8] and highlight the importance of considering both the influence of marital relationships on child temperament and the role of children's inherent dispositions in shaping family dynamics.

O.08.12 - Examining the Influence of Parental Depression on Children's Language and Socio-emotional Skills: Insights from a large-scale, nationally representative study of infants enrolled in Early Head Start programs

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Details

A child's socioemotional and language skills are shaped by interacting with their social environment (e.g., Cerezo et al., 2008; Masek et al., 2021; Rattaz et al., 2022). However, a caregiver's mental may affect children's burgeoning skills by restricting the opportunities and interactions that a child experiences. Furthermore, caregiver depression may also lead to greater conflict within the home environment. This study delves into the intricate interplay between parental depression and its repercussions on children's developmental trajectories—examining whether caregiver affects the relations between the home environment, parent-child interactions, and children's language and socioemotional skills. We hypothesize that children with depressed parents will have lower language scores and be more likely to exhibit problematic behaviors. Additionally, we predict that parental depression will be associated with more conflict and chaos in the home environment. Finally, we examine whether social support influences these relations.

Method

Sample. Data from the Early Headstart Family and Child Experiences Survey (Baby FACES), a large-scale, nationally representative survey of 0- to 3- year-old children enrolled in Early Head Start programs in 2018 (n=2,278). Early Head Start programs are designed to address the needs of low-income families throughout the United States.

All variables of interest were measured through surveys completed by the child's primary caregiver. Child production and comprehension language scores were measured by the Communicative Development Inventory (CDI). The Brief Infant Socio-Emotional Assessment measured children's problem behaviors and their social competence. The Healthy Families Parenting Inventory: Parent-Child Interaction subscale measured the quality of parent-child interactions and the Social Support subscale measured social support available to families. The home environment was assessed globally with the Confusion, Hubbub, and Order Scale (CHAOS) and family conflict was measured with the Family Environment Survey (FES).

The investigation focused on deciphering the influence of parental depression alongside other pertinent factors, including household chaos (CHAOS), family conflict (assessed through the Family Environment Scale - FES), and social support (measured via the Healthy Family Parent Interaction). These factors were examined for their potential impact on children's language development and behavioral patterns. Parental depression was measured with the CESD-R; data were dichotomized based on whether the parent met the criteria for a major depressive episode.

Results

Children with depressed parents were described as having significantly more problem behaviors (*t*(2.5, p = 0.01)) and poorer social skills (t(-2.3, p = .02)) than peers with non-depressed parents. There were no significant differences in language skills. Structural Equation Modeling using FIML elucidated unique relations between the variables of interest for children with depressed parents, compared to children with non-depressed parents (Figure 1).

Altogether, these analyses reveal intricate pathways through which parental depression interacts with household chaos, family conflict, and social support, consequently influencing children's developmental trajectories. The study sheds light on the multifaceted nature of these relationships, emphasizing the importance of considering parental mental health within the broader context of familial dynamics and environmental influences on children's development.

O.09: Caregiver-Infant interactions

O.09.01 - Quantity and quality of book reading to infants and toddlers: their effect on early communication and language development

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Details

Among the various parent-child interactions taking place in a typical family context, interactive shared book reading (ISBR) has been shown to have a superior value in fostering language development. Although many studies have established the linguistic benefits of ISBR in preschoolers, results on children younger than 3 years are scarce. This cross-sectional parent-report study explores the contribution of the quantity and quality of shared book reading to the communicative and language skills of a large sample of infants and toddlers growing up in Greek-speaking families. The parents of 740 children aged 6 to 36 months filled in the Interactive Shared Book Reading Strategies Questionnaire (ISBR_SQ) that assesses the number and frequency of interactive strategies adopted by caregivers during shared book reading. Parents were also administered the Communication Development Report (CDR), a norm-referenced parent-report screening tool that has been developed, validated and standardized for assessing communication and language skills of children growing up in Greek-speaking families. Results are presented on (a) shared book reading quantity (frequency) and quality (interactive strategies), (b) the effect of these two factors on children's nonverbal communication (nonvocal and vocal), as well as different dimensions of their language development (comprehension, expressive vocabulary, morphology and syntax). The effect of several contextual factors (age, gender, siblings, birth

order, parental education and economic status) is also examined. As for the shared book reading practices adopted by parents and their development across the age span of this study, both the frequency of book reading and the interactive shared book reading (ISBR) strategies used by parents were found to be significantly enhanced by children's age. Concerning the effect of the quantity and the quality of shared book reading on each of the six communication and language factors explored, overall, results confirm and extend previous findings regarding the benefits of shared book reading to children's vocabulary, morphology and syntax, pointing to the significant contribution of its quality rather than its quantity. They also add interesting findings regarding the significant contribution of shared book reading to children's nonverbal communicative skills. Finally, regarding the contextual factors explored, children's birth order, siblings and maternal education, appeared to have a significant -albeit low- effect on the quantity (frequency) but not the quality (ISBR strategies) of the shared book reading experiences of young children. Results are discussed based on previous relevant findings for their theoretical implications. Their applied interest in guiding the development of targeted, research-informed interventions aimed at promoting optimal language development from a very young age, is also discussed.

O.09.02 - Prenatal neural responding to infant emotional cues and postpartum observed sensitivity

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Details

Sensitive responding to infant cues has a lasting impact on children's socioemotional development (Fraley et al., 2013) and mothers' cognitive processing of infant cues is thought to organize mothers' sensitivity (Fuths et al., 2017). Event-related potentials (ERPs) index specific stages of cognitive processing, and thus, are a useful tool for examining mothers' cognitive processing of infant cues in relation to parenting behavior. Specifically, studies have examined ERPs, such as the N170 – reflective of early encoding of facial expressions – in association with parenting-related outcomes (Kuzava et al., 2019). However, current knowledge derives from cross-sectional studies, which do not allow evaluation of the direction of associations. To address this, the present study examines the predictive significance of mothers' prenatal neural responses to infant emotional expressions for mothers' postpartum caregiving behavior.

Sixty-three first-time expectant mothers attended a laboratory visit during their third trimester of pregnancy. Participants completed an infant emotion categorization task while their brain activity was monitored via electroencephalography (EEG). Stimuli for the infant emotion categorization task included 54 images of infants displaying either a distressed (*N* = 18), happy (*N* = 18), or neutral (*N* = 18) expression. Mothers indicated which expression the infant was displaying via button press. Mothers' N170 amplitude to each infant expression was extracted for analysis. When infants were four months old (*M* = 4.51 months, *SD* = 0.49), dyads returned to the lab. Maternal behaviors were observed in distress inducing contexts (e.g., diaper change, Still-Face Procedure; Tronick et al., 1978) and play contexts (e.g., play with and without toys). Interactions were coded for sensitivity to distress and

sensitivity to non-distress using scales adapted from the NICHD Study of Early Childcare (Frosch & Owen, 2016).

Preliminary findings show that sensitivity to distress was positively associated with mothers' N170 amplitude of distress versus neutral faces (r = 0.29, p = .029). Sensitivity to distress was not associated with mothers' N170 amplitude to happy versus neutral faces (r = 0.00, p = .994). Therefore, mothers who exhibited a larger N170 amplitude to their infants' distress facial expressions also responded more sensitively to their infants' distress signals. Sensitivity to non-distress was not associated with N170 amplitude (distress v. neutral: r = 0.09, p = .466; happy v. neutral: r = 0.00, p = .978).

Converging with prior evidence (Kuzava et al., 2019), findings suggest that mothers' neural responding reflective of differentiating distress from other expressions supports mothers' prompt, appropriate, and effective responding to their own infant's distress. Moreover, findings indicate that even prior to the birth of their infant, mothers' neural processing of infant cues holds significance for their subsequent parenting behavior, providing novel insight into the direction of associations between mothers' neural processing of infant cues and caregiving behavior. Ultimately, findings might inform the timing and targets of intervention, suggesting that interventions aimed at promoting mothers' awareness of infant emotional signals prior to infant birth might enhance subsequent parenting outcomes.

O.09.03 - Enhancement of phonological features in infant-directed speech matches time-course of feature acquisition

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Details

Infants start acquiring the phoneme categories of their native language within their first year of life. Parental adaptations in infant-directed speech (IDS) may help infants to achieve this. In particular, enhancements of individual phonemes seem to aid phonological acquisition (e.g., Liu et al., 2003). In the brain, acquired phonemes are represented as bundles of so-called phonological features (Mesgarani et al., 2014). These features specify, for instance, the class, manner, and place of articulation of a phoneme; they become activated when the speech sound is perceived. Here, we are asking: Do parents enhance features when interacting with infants?

We investigated longitudinally maternal enhancement of features across infants' first two years of life in 98 mother–infant dyads (CHILDES; Newman et al., 2016). Time-aligned phonological transcripts of maternal speech towards infants aged 7, 11, and 24 months were obtained. We focused on two measures that we have recently shown to associate with feature acquisition (Menn et al., 2023a): First, we focused on the durations of features in speech; this is based on the observation that features

typically do not change for every individual phoneme, but often span multiple successive phonemes and are therefore longer than individual phonemes. Feature durations were measured as the median duration of each feature from onset to offset of across feature-continuous stretches of speech. Second, temporal convergence of feature durations and prosodic modulations were assessed, given that previous findings suggest phonological feature acquisition may expand upon infants' initial focus on prosody (Menn et al., 2023a). Temporal convergence was computed as the cross-correlation between phonological features and the pitch track.

Mixed-effects models revealed enhancements in duration (t = -8.53, p < .001) and prosodic similarity of phonological features (t = -16.21, p < .001) when mothers were interacting with infants compared to experimenters (adult-directed speech; ADS). Feature enhancements in IDS decreased with infant age (duration: t = -5.08, p < .001; prosodic similarity: t = -5.41, p < .001). Importantly, the trajectory at which features become ADS-like differs between features (both p < .001).

Why do parents enhance some, but not other, phonological features for a longer period of infants' lives? We assessed a potential relationship between the developmental trajectory of phonological feature enhancement in IDS and the order at which features are acquired in infancy, taken from our cross-sectional electroencephalography results (Menn et al., 2023a). Strikingly, the current corpus analysis shows that maternal enhancement of phonological features decreases faster for those features that infants acquire at an earlier age (duration: t = -3.06, p = .002; prosodic similarity: t = -12.25, p < .001).

Our corpus analysis indicates a dynamic interplay between parental enhancements of phonological features and infants' acquisition of these. Initially, infants' brains operate at slow speeds, which bias speech perception towards the slow acoustic modulations at the prosodic rate (Menn et al., 2023b). We suggest that parental enhancements in the duration and prosodic similarity of phonological features in IDS helps infants in detecting and identifying features—analogous to prosodic bootstrapping. Thus, IDS may be optimized for infants' cognitive and neural means of learning.

O.09.04 - Associations between parents' psychological well-being and the context of media use with and around infants

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Details

The impact of media use on child development depends partly on the context of media use; parent-child joint media engagement is associated with more positive outcomes (Padilla-Walker et al., 2020) while technoference (i.e., displacement of parent-child interactions by media use) is associated with more negative outcomes (McDaniel & Radesky, 2018). Parents' psychological well-being may influence the context of media use, including the reasons they use media with and around their children (e.g., to calm their child, Beyens & Eggermont, 2014) as well as their degree of technoference (Wolfers, 2020). Thus, we examined associations between parents' stress and burnout, their reasons for using media, and both technoference and joint media engagement.

Participants were 245 predominantly white (73%), college-educated (90%) parents (88% mothers) with a toddler 12-23 months old (M_{age} = 17 months). Parents reported on parenting stress (PSS; Berry & Jones, 1995), parental burnout (PBA; Roskam et al., 2018), reasons for using media with and around young children (RUM; Suh et al., 2023), technoference (DISRUPT; McDaniel, 2021), and parent-child joint media engagement (MAQ; Barr et al., 2020). The RUM scale captures parental motivations for using media for themselves and their children, consisting of four subscales: 1) to regulate the parent's own emotions, 2) to help the parent relax, 3) to regulate their child's emotions and behaviors, and 4) for instrumental use, including occupying the child so the parent can do their work or chores and relaxing together.

A path analysis tested links from parenting stress and burnout to media reasons, and from media reasons to technoference and joint engagement (Figure 1). Findings demonstrated distinct associations between parenting stress, burnout, and the reasons for parent and child media use. Parents who reported higher parenting stress were more likely to use media to regulate their own emotions (β = .29, p < .001) and to regulate their child's behaviors and emotions (β = .26, p < .001). Conversely, parents who reported more parental burnout symptoms were more likely to use media for themselves to relax (β = .24, p = .002). Media reasons were also associated with parent-child interactions in the context of media use. Parents with more frequent use of media to regulate their own emotions reported greater media-induced disruptions to parent-child interaction, indicated by the technoference item of the DISRUPT scale (β = .29, p < .001). Parents' frequency of media use to relax predicted both technoference and joint media engagement with their child (technoference: β = .20, p = .003; joint engagement: β = .20, p = .005). Finally, parents who relied more frequently on using media to regulate their child's emotion and behaviors were less likely to experience technoference and jointly engage in their child's media use (technoference: β = -.22, p = .011; joint engagement: β = -.23, p < .001).

Overall, these findings showed the interplay of parent well-being, reasons for using media in the family, and parent-child interactions during media use. Stress and burnout were associated with different reasons for media use. Similarly, the reasons for using media predicted the extent to which media use displaces versus enables parent-child interaction. Future work should extend this cross-sectional analysis by examining associations between these constructs over time.

O.09.05 - Learning in an interest-driven context: the effect of young children's selective interests across language development

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Details

Parents often report their children being intensely interested in certain objects from their environment. As primary caregivers, they play a vital role in nurturing these interests; they provide toys and playthings for their child, engage them in every-day activities like shared book-reading, thus constituting a vital source of variability in their children's language input, which in turn influences their lexical diversity (e.g., d'Apice et al., 2019; Sosa, 2016). Simultaneously, research also suggests that children actively influence their learning, by actively pointing and vocalising to elicit information they are interested in,

and retaining such information better (Mani & Ackermann, 2018). In addition, previous studies demonstrate that young children show robust learning of novel word–object associations when they were interested in the category the object belongs to (Ackermann et al., 2020). While such interests develop young as 18 months, it is unknown how these interests are sustained across early childhood, and how they influence language development and daily interactions.

Against this background, we present two studies that (a) takes a longitudinal look at the development of children's interests in particular object categories, and subsequent effect on their vocabulary, and (b) examines whether children's interests modulate quality of parent-child interactions and subsequent novel word retention.

(a) In the first study, we examined 56 young children at two timepoints in development – at 18 and 24 months. We obtained children's interests in various natural object categories by way of, firstly, parent estimates of their children's interests via questionnaire, and secondly, children's pupillary arousal toward familiar objects from different categories, at both these timepoints. We also collected parent estimates of children's category-specific vocabulary knowledge via questionnaire. We found here that parents report that children's category-specific interests are sustained over a 6-month period, and that parent estimates of interest (but not children's pupillary arousal) at 18 months predict the size of the category-specific vocabulary at 24 months.

(b) In the second study, 79 parent-child dyads (children 24-30-months-old) participated in a shared book-reading task, where the dyads read two books chosen by parents; one of high and one low interest to the child, with one novel word-object mapping in each book. Children completed a preferential-looking task for us to assess children's interest in our book-categories. Finally, we also examined children's later recognition of newly-introduced word-object mappings. Here, we found that parent-child quality of interaction varied as a function of children's interest in the books. However, though we found that children successfully learnt the novel words presented in the books, we found no effect of children's interest (indexed either by parent choice of high- and low-interest books or children's preferential looking behaviour), or interaction quality on novel word learning.

Taken together, we show that children's sustained individual interests during their formative years influence the trajectory of their category-specific vocabulary size, and later, their selective interests also influence the quality of interaction during shared book-reading, although its direct influence on word learning is no longer apparent.

O.09.06 - Understanding daily mother-toddler communication patterns: The role of toddler temperament and maternal sensitivity

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Details

Parent-child conversations are the central context where early communicative skills develop. While parental responsiveness to child (pre)verbal vocalizations is widely known to support early language

development (Tamis-LeMonda et al.,2014), little research has looked at the immediate effect of parental responsiveness on the child's subsequent communicative behaviors. Notably, parent-child conversations are often studied in brief, semi-structured settings, characterized by high rates of parental responsiveness and striking absence of silence (Tamis-LeMonda et al.,2017). However, this is not representative of everyday parent-child communication, where parents balance various competing responsibilities besides tending to their child's needs. Moreover, within naturalistic contexts, it is important to consider factors that may account for individual differences in everyday communication. For instance, children high in negative affectivity tend to elicit lower parental responsiveness (Kiff et al.,2011) and sensitive mothers are more likely to be verbally responsive (Alvarenga et al.,2021).

Addressing these gaps, we explored the interplay between toddler temperament and maternal sensitivity in predicting mother-toddler communication patterns using Language Environment Analysis (LENA; Xu et al.,2009). Twenty-five toddlers (M=16.60 months; 92% White) wore a LENA recorder for a full day and completed semi-structured tasks with their mothers, from which maternal sensitivity was coded (NICHD ECCRN,1999). Mothers reported on child temperament and language ability. Using LENA's automated processing technology, we identified three sequential patterns representing important aspects of parent-toddler conversations: maternal response to toddler (pre)verbal vocalization (VOC->MOM), toddler (pre)verbal vocalization following maternal response (VOC->MOM->VOC), and parental conversation initiation (SILENCE->PARENT).

Results (see Table1) show that maternal responsiveness (VOC->MOM) was significantly higher for toddlers with higher effortful control, β=.468, *p*=.020. When mothers responded, toddlers with higher effortful control were more likely to vocalize next (VOC->MOM->VOC; β=.483, *p*=.015), whereas those with higher negative affectivity were less likely to do so, β=-.411, *p*=.034. Surprisingly, neither toddler language ability nor maternal sensitivity predicted these sequences. Finally, the interaction between toddler negative affectivity and maternal sensitivity predicted the probability of parents initiating conversations with their toddler (SILENCE->PARENT; β=.452, *p*=.034; see Figure1). In families with highly sensitive mothers, parents were *more likely* to initiate conversations when their toddlers are higher in negative affectivity, β=.48, *p*=.04, whereas in families with less sensitive mothers, higher negative affectivity predicted *lower* likelihood of such initiation, β=-.50, *p*=.04.

Altogether, toddler effortful control promotes maternal responsiveness to (pre)verbal cues and toddler's subsequent engagement in communication. Interestingly, toddler negative affectivity appears to hinder their subsequent vocalization following maternal response. Families with highly sensitive mothers appear to have compensated for this communication gap by more frequently initiating conversations with toddlers higher in negative affectivity.

Our findings illuminate the role of toddler and parenting characteristics in understanding daily parent-toddler communication patterns. The importance of employing ecologically-valid measurement, strengths and limitations of automated processing technology, and future directions for examining these patterns longitudinally, will be discussed.

O.09.07 - Mothering and fathering: Similarities and differences related to family cultural context

Margaret Owen [1], **Katharine Suma** [2], **Raul Rojas** [3], **Roger Bakeman** [4], **Margaret Caughy** [2]

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Details

Objective. Across populations, parents are children's first teachers—socializing behavior, values and beliefs, and providing stimulation to support healthy development. Even in interactions with infants and toddlers, parenting behaviors are imbued with cultural value and transmit meaning. Group differences in affective communication and regulation within parent-child interactions are a function of differences in cultural values related to emotion socialization, expressivity, and affective regulation. How culture may influence the parenting behaviors of mothers and fathers differentially was examined in the current study. Of note: Most existing work examining culturally specific practices of parenting in Hispanic-American and Black American families in the U.S. has focused on mothers rather than fathers.

One of the prominent themes in the research on mothering in Hispanic families (in this presentation referring to those whose ethnic origin or descendancy is from Spanish-speaking countries in Latin America) is the key role Hispanic mothers play in establishing and perpetuating the culturally relevant values of *familismo* and *respeto.* Black American parenting integrates the cultural influence of ancestral heritage, minoritized status, and mainstream values; socializing children to be able to navigate experiences of prejudice is particularly salient for Black American parents. Black American mothers provide a combination of warm and hostile behaviors to indicate both love and fear for well-being.

Method. Global ratings from two prominent rating systems were made from videos of 15-min mother-child and father-child interactions collected in the homes of co-residing Black American families (only 1 parent foreign born) (n = 80) and Hispanic families (94% Mexican American and 85% of mothers foreign born) (n = 118) with their children aged 2½ years, all residing in a major metropolitan area in the southwestern United States. Recruited families reported low household incomes, with Black American families more often reporting incomes below the U.S. federal poverty level (76%) than the Hispanic families (57.6%); parents' formal education was higher among the Black American than the Hispanic families.

Results. Paired t tests were used to compare mothers and fathers in the same family, and independent t tests were used to compare Black American and Hispanic parents as well as parents of boys with parents of girls, with the size of mean differences characterized using Cohen's d statistic. There were more differences between mothers' and fathers' behavior ratings in Hispanic families than in Black American families. Hispanic mothers displayed higher levels of cognitive stimulation, negative regard, calm authority, and scaffolding and lower levels of active direction compared to Hispanic fathers, with small to moderate effect sizes. Only the ratings of positive regard and of exploration activation differed between Black American mothers and fathers, with mothers rated higher than fathers; effect sizes were small to moderate. Child behavior ratings with mother and with father also differed between the two ethnic groups, and more rating differences by child gender were found among the Hispanic than the Black American families.

The complexity of culture-related differences found between mother-child and father-child interactions and how they speak to the need for follow-up among diverse samples and in relation to child outcomes will be discussed.

O.09.08 - Tiny screens, big impact: Investigating the effects of smartphone use on maternal and infants' stress and interaction dynamics

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Details

Smartphones can attract people's attention in such way that they are completely absorbed by the content of the phone and abruptly interrupt interactive behavior – so-called technoference (McDaniel & Coyne, 2016). This is particularly critical when it affects interactions between parents and their infants, who have underdeveloped self-regulatory abilities and thus highly depend on emotionally available and sensitive caregivers (e.g., Morris et al., 2017). Studies showed that parental media use generally entails more negative parenting practices (e.g., Abels, 2018; Elias, 2021; Vik, 2021) and has negative effects on infant behavior (e.g., Elias, 2021; Lemish et al., 2019), affectivity, and physiological arousal (Rozenblatt-Perkal et al., 2022). However, little is known about the effects of maternal smartphone use on children's autonomic and behavioral stress response, as well as whether individual differences in parenting behaviors during and directly after smartphone use affect children's perceived stress.

To address these questions, we used a multi-method approach combining behavioral and physiological measures to examine the effects of smartphone-induced interruptions during early interactions. We recruited 68 mothers and their infants (M = 6.5 months; *range* = 3-9) and observed them during a modified still-face paradigm. The classic still-face procedure (i.e., interaction, still-face, reunion) was extended by a smartphone interruption and a following reunion phase. During this procedure, we video-recorded mothers' and infants' behavior and measured maternal and infant heart rates using an electrocardiogram (ECG). In addition to the analysis of cardiovascular activity, we are currently micro-coding infants' protest and self-regulatory behavior (e.g., facial expression, self-touch, vocalizations) and maternal co-regulatory behavior (e.g., gaze, affective touch).

Preliminary analyses show a significant increase in infants' heart rate during both the still-face ($p < .001$) and smartphone interruption phases ($p < .001$), compared to the initial interactive episode (see Figure 1). There was no significant difference in infants' heart rate between the still-face and smartphone phase ($p = .077$). Maternal heart rate increased from the still-face to the following reunion phase ($p < .001$) as well as from the smartphone to the following reunion phase ($p < .001$; see Figure 2). In addition, we found a significant association between children's heart rate and protest behavior during maternal smartphone use ($r = .44$; $p = .004$).

These findings suggest that infants perceived parental distraction during smartphone use to be just as stressful as being completely ignored during a still-face, as indicated by their increased heart rate and protest behavior, particularly during the smartphone phase. Furthermore, the increase in maternal heart rate from both interruption phases to the subsequent reunion episodes indicates her efforts to restore the interaction with their children, regardless of type of interruption. Our continued analyses of maternal behavior may further support this assumption. Overall, the results of this study emphasize the relevance of investigating the short- and long-term effects of parental smartphone use on children's experience and development.

O.09.09 - The influence of infants' temperament in parent-infant interactions

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Details

Parent-child interactions highlight the impact of parental input, considering both the quality, also known as infant-directed-speech (IDS), and quantity of interactions, on child development (Kalashnikova & Burnham, 2018; Tamis-LeMonda, Bornstein, & Baumwell, 2001). However, communication is a dynamic exchange involving at least two individuals, yet, little is known about how infants influence these interactions.

In the current study, we investigate how infants' temperament influences parent-infant interactions. We recruited 35 English-learning infants at the age of 4 months and obtained their temperament score via parental questionnaires using the Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003). The IBQ-R consists of multiple scales that are grouped in three factors: Surgency (extroversion and high sensory perception), Regulatory/ Orienting (attention and emotional regulation), and Negative Affectivity (distress, fear, and sadness). Quality of parental input was obtained via IDS recordings during interactive play sessions and analysed acoustically for evidence of vowel hyperarticulation (Kalashnikova & Burnham, 2018; Liu et al., 2009). Quantity of parental input was collected from daylong recordings (minimum 10 hours recording time) and we extracted Adult Word Count (AWC), and Conversational Turn Count (CTC) using the LENA system (Xu et al., 2009).

Our findings reveal that despite mothers expanding their vowel space, this was not influenced by the infant's temperament, see Figure 1. However, regarding the quantity of parental input, we observed a relationship between the infant's temperament and the number of conversational turns between infants and adults ($F(5, 29) = 2.999$, $p = 0.027$). We observed fewer conversational turns between infants and adults when the infant exhibit more extrovert (higher scores in Surgency) temperament and fewer conversational turns with infants who had higher attention and emotional regulation (higher scores in Regulatory/ Orienting) temperament, see Figure 2. The number of adult words were not influenced by infants' temperament scores.

We suggest that infants exhibiting extrovert temperament might not show their temperament in vocal activity but rather in other forms of social interactions. In contrast, infants with stronger attention and emotional regulation might create fewer opportunities for parent interactions due to their higher self-regulation levels. These findings suggest that infants' temperament shapes how adults *talk with* infants (conversational turns), rather than how adults *talk to* infants (IDS, number of adult words). Our results underscore the infant's role in communication scenarios.

O.09.10 - Infant directed speech in UK and Ugandan mothers: an assessment of acoustic features across societies and within three Ugandan Languages

Ellie Donnelly [1], **Ed Donnellan** [2], **Santa Atim** [3], **Joanna Buryn-Weitzel** [2], **Rebecca Crowther** [4], **Beatrice Forward** [4], **Kirsty Graham** [2], **Maggie Hoffman** [5], **Eve Holden** [2], **Michael Jurua** [3], **Charlotte Knapper** [2], **Sophie Marshall** [2], **Josephine Paricia** [3], **John Sajabi** [3], **Georgia Tuohy** [4], **Florence Tusiime** [3], **Carlo Vreden** [4], **Claudia Wilke** [2], **Zanna Clay** [4], **Katie Slocombe** [2]

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Details

Infant directed speech (IDS) is a special speech register which is typically slower-paced, high-pitched, with greater pitch modulation and larger vowel space than adult-directed speech (ADS) (Saint-Georges et al., 2013). Such acoustic modifications allow IDS to play a key role in the development of infant attention (Senju & Csibra, 2008), language (Golinkoff et al., 2015) and emotion (Fernald, 1992). Although IDS has been identified across diverse language types, IDS acoustic features may vary across both languages and cultures (Cox et al., 2023; Hilton et al., 2022). Previous research has focused overwhelmingly on Western Educated Industrialised Rich and Democratic (WEIRD) populations (Nielsen et al., 2017) and has often involved small sample sizes, so cultural variability of IDS acoustic features are poorly estimated. Variation in IDS acoustic features as a function of language within non-WEIRD cultures has been so far overlooked in the literature. In fact, language and culture are often confounded in cross-cultural comparisons of IDS. To address these issues, we analysed a dataset from (N=233) mother-infant dyads in the UK (N=133) and Uganda (N=103). Within the Ugandan sample, the mothers spoke either Alur, Lugbara or Swahili with their child and all UK mothers spoke English with their child. To obtain audio recordings of IDS and ADS, we visited mothers and infants in their homes. We asked mothers to interact and talk to their child and separately to an adult experimenter (in the same language) as they normally would. We also provided three objects whose names contained the corner vowels /i/, /u/, /a/. We asked the mothers to show these objects separately to their infant and name them for their infant and experimenter. We performed acoustic analyses on audio recordings of these interactions using Praat. Significant interactions between speech type (IDS/ADS) and society (Uganda/UK) were found for three acoustic measures. In line with previous findings, IDS was significantly higher in mean pitch and pitch modulation than ADS in both Uganda and the UK, but this difference was significantly more pronounced in the UK. Speech rate for IDS was significantly slower than ADS in both samples, but this effect was significantly more pronounced in Uganda. We found no evidence of group level vowel hyperarticulation in either population, supporting the fragility of this feature of IDS (Cox et al., 2023). In contrast to the differences in the extent that the two societies acoustically modified IDS compared to ADS, we found far fewer within-society differences between languages spoken by the Ugandan mothers. For Ugandan participants, language had a significant effect on pitch modulation only, with Swahili speaking mothers having a significantly great pitch modulation in IDS than ADS compared to Alur and Lugbara speakers. Taken together, our results suggest that cultural context may have a more important influence than language on the acoustic features of IDS.

O.09.11 - An acoustic study of Korean mothers' vowel production

Eon-Suk Ko [1], **Sunghye Cho** [2]

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Details

We investigate the vowel hyperarticulation hypothesis (Kuhl et al., 1997; Burnham et al., 2002) through a word-teaching task conducted with Korean mothers. Previous IDS vowel production research reports conflicting findings (Benders, 2013; Englund & Behne, 2006; Cristia & Seidl, 2014), potentially stemming from various factors like word contexts, complexity, infant age, and operationalization methods. Commonly used formant and vowel space comparisons for hyperarticulation may overestimate. Addressing this, the Vowel Hypo- and Hyper-articulation (VHH) index (Marklund & Gustavsson, 2020) emerges as an alternative metric, calculating the Euclidean distance in F1-F2 vowel space. We compare these methods while controlling for confounding factors in the statistical model, and show that our data support the vowel hyperarticulation hypothesis.

Twenty-two mother-infant dyads participated in the study, comprising 17 prelexical infants (M=309, SD=44 days) and 5 early-lexical infants (M=502, SD=1 day). The word-teaching task involved nonce words with vowels /a/, /i/, and /u/ in the initial syllable, serving as labels for novel objects. The procedure included the initial reading of books containing the stimuli and spontaneous explanations. Each participant taught the words to both their child and a confederate adult. The analysis focused on a total of 2883 vowel tokens, which were coded based on speech nature, word distinction, and sentence position.

For robust formant estimation, we individually optimized the formant ceiling for each speaker and vowel type by varying the maximum formant ceiling from 4500 Hz to 6500 Hz in 10 Hz increments (Escudero et al., 2009). Subsequently, outliers were identified and excluded using z-scores. The variance of F1 and F2 values was initially compared between registers using Levene's tests. Following this, differences in F1 and F2 values for a given vowel were examined through linear mixed-effects models. These models incorporated speech register (IDS/ADS) and task (reading/spontaneous) as independent variables, with speakers considered as random variables. Euclidean distances between vowel pairs were calculated based on averaged F1 and F2 values. Additionally, the expansion of vowel space in IDS compared to ADS was investigated. Paired t-tests were employed to compare Euclidean distances and vowel space areas. Furthermore, the VHH index, computed for each vowel token per speaker, underwent comparison using linear mixed-effects models.

The vowel space area was observed to be larger in IDS compared to ADS, although a larger space does not always indicate hyperarticulation. Leveraging the VHH index, our study confirmed that Korean mothers indeed hyperarticulate vowels in IDS. This underscores the significance of robust formant estimation and the utility of the VHH index in accurately capturing hyperarticulation patterns. Notably, our study improved upon previous research by ensuring a balanced number of tokens in both IDS and ADS, with both involving the same task of introducing novel objects. While raw formant values alone don't consistently confirm enhanced vowel categories in IDS, our findings align with recent English IDS studies, indicating increased within-category variation in IDS compared to ADS. These results emphasize the importance of careful methodological considerations in uncovering aspects of IDS accommodation that might be overlooked with conventional approaches.

O.09.12 - Exploring the impact of technoference on mother-infant brain-to-brain synchrony using a smartphone-adapted still face paradigm

Marion Van Den Heuvel [1], **Agata Mosińska** [1], **Elise Turk** [1], **Maryam Alimardani** [1]

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Details

The quality of mother-infant interactions is crucial for healthy socio-emotional development in infants. Currently, the ubiquitous presence of mobile devices offers countless opportunities for distractions, inevitably impacting face-to-face interactions. This study investigated the effects of maternal distraction by digital devices, also known as “technoference”, on mother-infant brain-to-brain synchrony. We collected data from thirty three mother-infant pairs participating in a double smartphone-adapted Still Face Paradigm (s-SFP) that incorporated maternal smartphone distraction. The s-SFP consisted of 5 phases of each 2 minutes, including: 1) free play (baseline), 2) still face (smartphone interruption), 3) free play, 4) still face (smartphone interruption), 5) free play (reunion). Using a dual-EEG set-up, we assessed brain-to-brain synchrony, which was subsequently quantified using the Phase Locking Value (PLV) analysis. The analysis focused on the infant's theta (3-5 Hz) and alpha (6-9 Hz) frequency bands, which are known for their role in social interactions. We first compared global PLV values between the free play conditions and the still face conditions. Here, we found that smartphone interruptions disrupted mother-infant synchrony in the theta frequency band, but not in the alpha frequency. Next, regional analyses (frontal, central, temporal, and occipital) indicated multiple significant differences between free play and still face in the theta band (Figure 1) and one significant difference in the alpha band (decreased synchrony between maternal central and infant right temporal region in still face conditions). These results align with earlier research, highlighting the theta band's heightened sensitivity to disruptions in social interactions. Importantly, brain-to-brain synchrony returned to baseline during the reunion, suggesting that mother-infant synchrony can be restored when the mother reengages in the interaction. Overall, our findings seem to emphasize the need to minimize technological distractions in daily life.

Poster Abstracts

Poster Session 01

P1-A-1 - Spatial organization of reaching patterns to the mouth in the first six months

Audrey Hwang [1], **Colin Foley** [1], **Wendy Jung** [1], **Jeffrey Lockman** [2]

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Details

Introduction

Previous research indicates a developmental shift in infants' reaching and grasping behavior, transitioning from a predominantly ipsilateral pattern to a more contralateral one between the ages of four and seven months. (Morange & Bloch, 1996). Left-handed reaching was also shown to be less direct and precise at this age (Morange-Majoux et al., 2000). However, virtually all work on the spatial

organization of reaching has been conducted using tasks in which infants reach to stimuli located in peri-personal space, external to the body. Little is known about how reaching to one's own body is spatially organized. In the present study, we examine lateralization patterns when young infants bring their hands to their faces, either when holding or not holding an object. Specifically, we consider whether reaches toward the face were ipsilateral or contralateral and whether infants were more likely to use their left or right hands.

Methods

We studied 25 infants longitudinally between two- and six-and-a-half months old, approximately every two to three weeks. During each lab visit, infants were seated in a reclined baby chair. Infants were observed in two-minute trials in which either nothing was placed in their hands or a pacifier attached to a small wooden rod was placed in their hand (M=5 visits, average weeks between visits 2.7). Trials ended when the baby became fussy. Two independent researchers coded the videos, documenting where the hand/object touched and the hand responsible for the touch. The average kappa across all categories was .887 (93.14% agreement). We defined success as the ability of the infant to bring their hand to their mouth.

Results

Results showed that infants were more successful in bringing their right hand than their left hand to their mouth (Wald χ^2_1=4.766, p=.029; see Fig. 1). Additionally, while left-handed touches were relatively stable in their probability of making an ipsilateral touch, right-handed touches started more ipsilateral at two months and became more contralateral by six-and-a-half months when infants made contact to a lateral part of the face (Wald χ^2_1=9.035, p=.003; see Fig. 2). No differences were found as a function of holding an object in hand.

Conclusion

In summary, the findings indicate that during the first six months, infants more often bring the right than the left hand to the mouth. Additionally, during this period, infants show a developmental shift from ipsilateral to equally ipsilateral/contralateral reaches for right-handed but not left-handed touches to the lateral sides of the face. Taken together, these findings suggest that prior laterality results for reaching for external objects in space extend to reaching toward locations on one's face, thus offering a broader context for understanding the development of reaching lateralization during the first six months.

P1-A-2 - Dynamic assembly of posture and manual sampling during play with manipulative toys

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Details

Development is a complex process. The dynamic systems approach describes it as an assembly of multiple self-organizing elements that are constantly changing and influencing each other (Smith & Thelen, 2003). Infants' behaviors are intricately shaped by a complex interplay of elements, allowing for a flexible arrangement that adeptly responds to tasks and environmental demands (Thelen & Smith, 1994).

Notably, manual sampling of information is a skill that cannot be interpreted outside the environmental context (D'Souza & D'Souza, 2021). Research indicates that variations in how infants sample objects are closely connected to postural development (Kretch, Franchak, & Adolph, 2014; Cole, Robinson & Adolph, 2015; Schneider et al., 2022). For instance, the independent sitting position favors sensory object exploration due to the increased mobility of now-unoccupied hands (Libertus & Violi, 2016; Luo & Franchak, 2020).

Despite the complexity of assembled sensory input, motor skills, and cognitive processes, stable behavioral patterns emerge during infant development. While extensive studies have delved into the developmental trajectory of infants' manual sampling, such as its connection with the increasing specialization of motor abilities in the first year of life (D'Souza et al., 2017), a notable gap exists in understanding contextual dynamics arising from the environmental complexity.

To address this gap, we analyzed spontaneous behaviors in 9-month-old infants (N=30) during 5-minute-long, unstructured, dyadic play with four toys (Figures 1 and 2) differing in opportunities for action. Coding infants' manual sampling and body position frame-by-frame allowed us to explore the contextual environment of sampling episodes.

Initially, we compared infants' interactions with each toy across various body positions (Figure 1). A two-way ANOVA on unimanual and bimanual sampling behaviors revealed significant main effects of both body position (unimanual: $F(3)=5.05$, $p=.002$, $\eta^2=.05$; bimanual: $F(3)=3.16$, $p=.031$, $\eta^2=.10$) and toy (unimanual: $F(3)=8.96$, $p<.001$, $\eta^2=.09$; bimanual: $F(3)=3.62$, $p=.018$, $\eta^2=.12$) on the median duration of a sampling episode.

As infants in total spent 54% of the time during the task on sitting independently, we next focused on their sampling behavior within the sitting posture (Figure 2) to gain insights into how infants approached specific toys. A Kruskal-Wallis test unveiled significant differences in the median duration of both unimanual ($H=20.55$, $p<.001$) and bimanual ($H=15.97$, $p=.001$) sampling across toys. Further post-hoc pairwise Games-Howell tests pinpointed specific differences: unimanual sampling varied significantly between bubbles and spinner ($t(21.96)=3.11$, $p=.02$, $\eta^2=.20$), dino and klickity ($t(25.91)=3.05$, $p=.02$, $\eta^2=.19$), and dino and spinner ($t(24.92)=3.63$, $p=.007$, $\eta^2=.24$). Infants also exhibited distinct bimanual sampling behavior between bubbles and spinner ($t(18.82)=2.85$, $p=.04$, $\eta^2=.18$).

The findings indicate that infants demonstrated distinct sampling patterns based on the toys' characteristics and body position. Toys providing a particular affordance, the spinner and klickity, were associated with numerous shorter and more stable episodes. In contrast, toys promoting general exploratory sampling, bubbles and the dino, were linked to fewer but longer episodes that were more variable in duration. In conclusion, our results show that 9-month-olds reliably adapt their exploration strategies within diverse postural constraints and possibilities for action. These insights offer valuable implications for the early specialization observed in manual sampling.

P1-A-4 - Self-touch over the first 18 months of life

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Details

Self-touch has been hypothesized to promote the development of infants' knowledge about the layout of the human body and infants' representation of the self. Although self-touch has been investigated in infants under six months of age (DiMercurio et al., 2018; Thomas et al., 2014), little is known about the subsequent development of this behavior as infants become more accurate at reaching to stimuli on their own bodies (Chinn et al., 2019; Leed et al., 2019). To address how self-touch develops in the first 18 months, we developed a new procedure to record infants' self-touch behaviors while they were seated in a stroller, which was being pushed by their caregivers. From the video-record, we coded where infants touched their own bodies. We also examined touches performed by the feet as an additional dimension of self-touch that has yet to be considered empirically.

Twenty-nine 3- to 18-month-olds (mean age = 322.17 days) were filmed from a GoPro camera mounted to the sunshade of a stroller for 10 minutes while being pushed by their caregivers. Videos were coded for locations of the body touched (head, torso, and lower body) and which limbs performed the touches (left and right hand or foot). After initial coding, 26% of the videos were double coded and analyzed for interrater reliability. The double coding showed 86.95% touch occurrence agreement, 97.81% location touched agreement, 99.60% touched *by* agreement.

Analyses were conducted using generalized estimating equations with the negative binomial distribution and log link function. Results indicate a significant interaction between location touched and age (Wald X^2 =7.48, p =.024 < .05). Post-hoc tests revealed that the location intercepts were significantly different from one another, such that at younger ages, lower body touches were more prevalent than torso and head touches. The foot touch analysis yielded a significant main effect for age such that foot touches to the other leg decreased with age (Wald c^2 =12.97, p < .001).

Taken together, the findings provide new information about how self-touch changes during infancy. As infants are being pushed in a stroller, the frequency of infants' hand touches to the head and torso regions remains relatively stable over the first 18 months, but the frequency of hand touches to the lower body regions decreases over the same period. Likewise, foot touches to the opposite leg decrease with age. Overall, with respect to the absolute levels of self-touch, the findings suggest that even over a 10-minute period, infants explore their entire bodies relatively frequently. Additionally, the age-related decreases in hand-touches to the legs in combination with fewer foot touches to the opposite leg suggest that the legs and feet have become more specialized for locomotion and become used relatively less as an effector to explore the body.

P1-A-5 - Associations between atypical sensory processing patterns and motor, language, and cognitive abilities in 9-month-old infants

ICIS 2024 Abstract Book

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Details

Background: Early infant sensory experiences are important for motor, cognitive, and social development and contribute to the further development and refinement of sensory processing systems (Ahn et al., 2004; Dunn, 2007; Gibson & Pick, 2000). Individuals who have extreme responses in processing patterns are identified as having atypical sensory experiences which have been found to exacerbate learning, developmental, and behavioral difficulties (Leekham et al., 2007). Understanding infant atypical sensory experiences may be important in identifying specific challenges in learning and developmental outcomes.

Objectives:1)Describe atypical sensory patterns in 9-month-old infants with elevated genetic likelihood for ASD, infants born preterm, and typically developing infants; 2)Investigate associations between atypical sensory patterns and concurrent motor abilities; 3)Investigate associations between atypical sensory patterns and subsequent motor, cognitive, and language abilities at 12-months.

Methods: Participants from a longitudinal study of infant development included 9-month-old infants (N=84) at elevated genetic likelihood for ASD (n=27), infants born preterm (<37 weeks, n=32), and term infants at low likelihood for ASD (n=25). Parents completed the Toddler Sensory Profile-II (TSP2, Dunn, 2014) to evaluate 4 sensory processing patterns (seeking, avoiding, sensitivity, and registration) and 9-month-infants completed the Bayley Scales of Infant and Toddler Development, 3rd Edition. At 12 months, infants completed the Mullen Scales of Early Learning. Typical sensory patterns on the TSP2 were defined as raw scores within the Average range. Atypical patterns were defined as raw scores outside the Average range. Multiple linear regression models examined concurrent associations between 9-month atypical sensory processing and motor abilities and predictive associations between 9-month atypical sensory processing and 12-month motor, cognitive, and language abilities.

Results: Parent report of the TSP2 revealed that 45.6% of participants (n=40) had at least 1 atypical sensory pattern. Infants with at least 1 atypical sensory pattern had significantly higher motor scores than infants with typical patterns ($F(1,72)=5.97, p<0.05$). This was driven by infants with atypical registration patterns who showed significantly higher motor scores than those with typical registration patterns ($F(1,72)=7.73, p<0.01$;see Fig1). No significant differences in motor scores were found for other sensory patterns (all p's>0.05). In terms of predictive associations from 9 to 12 months, infants with at least one atypical sensory pattern at 9-months had significantly lower receptive language scores at 12-months than infants with typical sensory patterns ($F(1,68)=5.49, p<0.05$; see Fig2). Differences in sensory patterns were not predictive of gross and fine motor, visual reception, or expressive language scores (all p's>0.05).

Conclusions: Findings suggest that infants with atypical sensory patterns exhibit higher motor skills than infants with typical sensory patterns across likelihood groups, specifically atypical sensory registration. In 12-month-olds, atypical sensory patterns were not associated with developmental differences, other than receptive language skills. The difference in atypical sensory patterns on developmental domains at 9 and 12 months may suggest that sensory experiences related to infant responsivity may be an indicator for developmental progress.

P1-A-6 - Exploring the influence of tool use on the extension of peripersonal space in infants and young children

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Details

In the present studies we investigated the effect of tool use on infants' and young children's peripersonal space (PPS). PPS has been conceptualised as the space around our bodies in which our actions take place and body-related information is integrated with external information, so that we can, e.g., protect ourselves from a fast approaching object. In adults and older children the size of the PPS is dynamic and can be extended by using a tool. Judgements of object reachability have thus been shown to change after tool use to include objects further away from the body than before tool use. The question of the present studies was whether a comparable extension of peripersonal space could also be found in young children and whether it depends on the mastery of tool use. In the first study, 42 two-year-olds who were beginning to use tools efficiently, were tested (21 female) in a task of grasping toys which approached them across a table. Each toy was fixed with Velcro onto a rod and slowly pushed towards the children with short stops every 5 cm. Children were required to grasp the toy as soon as they felt that they could get hold of it. The point of first reach was taken to indicate children's perception of the object's reachability. The baseline phase consisted of 10 consecutive trials. Children's mean reaching distance represented PPS boundary. Subsequently, children were randomly assigned to either the tool use or the control group. Children in the tool use group were given a rake to retrieve different objects presented out of their reach across 15 trials. Children in the control group interacted with the same toys for the same time duration without using the tool. All children participated in the subsequent test phase that corresponded to the baseline phase. We tested whether the perceived PPS boundary had changed after the tool use training by comparing the mean reaching distances between baseline and test phase between the groups. An ANOVA yielded a significant main effect of phase (F (1,40) = 126,86, p = .021) and a significant interaction between group (tool use / control) and phase (baseline / test), (F (1,40) = 107,48, p = .033). This indicates a change in reaching distance from baseline to test in the tool use group, with children reaching at a greater distance at test as compared to baseline, but no difference between baseline and test in the control group. The data provide first evidence of a PPS extension after tool use in young children. In order to explore the question whether tool-use proficiency is required for PPS-extension, in the second study we are currently testing 12-month-olds, an age-group that is not able to use tools reliably, on the same task. Here, we attached Velcro to the rake and the rake to the children's hands, enabling them to use the rake to retrieve the toys, because they would stick to the rake when contacted. Results of this study will be presented as well.

P1-A-7 - Pilot TORCH Brazil Project: motor repertoire in 3- to 5- month-old infants prenatally exposed to syphilis and toxoplasmosis

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Details

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Background: Prenatal infections represent major causes of permanent disability among children in low- and middle-income countries. *Treponema pallidum* and *Toxoplasma gondii*, the infectious agents of syphilis and toxoplasmosis, can cross the placental barrier and cause damage to fetal brain. In Brazil, they have been topics of great concern in public health. This is the first study that investigated the spontaneous motor repertoire of infants who were prenatally exposed to syphilis and toxoplasmosis. **Objective:** To characterize the motor repertoire of 3-to-5-month-old infants who were exposed to syphilis and toxoplasmosis during gestation. **Methods**: Exploratory study with 15 exposed infants (34.4±3.5 weeks gestation) assessed at 12-20 (median 12) weeks post-term. General Movement Assessment, including the Motor Optimality Score-Revised (MOS-R), was used to assess fidgety movements (FMs) and coexisting motor patterns. Later motor outcomes based on clinical diagnosis and the Hammersmith Infant Neurological Examination (HINE) were obtained from medical reports when possible. Informed legal consent was obtained from parents. One-sample binomial tests were used for the analyses. **Results**: MOS-R ranged 10-26 (median 24). There was a higher proportion of infants with normal (80.0%) than aberrant FMs, but the proportion of infants with reduced MOS-R (80.0%) was higher compared to optimal MOS-R (Table 1). Only 13.3% of infants showed smooth and fluent movement character. All observed tongue movements were abnormal. Of the 3 infants with aberrant FMs, one was diagnosed with cerebral palsy at 12 months and other two presented risk of motor impairment at 9 months post-term based on the HINE (Table 2). **Conclusion:** Infants had predominantly normal FMs, but with reduced MOS-R and abnormalities in the coexisting motor repertoire. This signals the importance of monitoring this population closely to allow early intervention if necessary. This study encourages the development of the first Brazilian multicenter cohort study on this topic.

P1-A-8 - Longitudinal changes in infants' daily routines moderate object holding

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Details

Recent work characterizes base rates about infants' everyday opportunities for learning, such as the frequency and variety of everyday object experiences. However, infants' daily routines—which macro-level activities take place and when—likely moderate these micro-level experiences but often go unmeasured. For example, the frequency and type of objects may vary across different activities: Playing at home might offer abundant opportunities to handle toys; eating a meal in a highchair might provide frequent access to spoons, cups, and food; few objects might be present during a car ride. Although we

focus on objects as a model system, daily activity patterns may relate to variations in opportunities for other daily experiences, such as viewing faces, hearing speech/music, and walking.

Thus, the goal of the present work was to 1) determine the relative time spent in different everyday activities (e.g., playing, eating, errands, etc.), 2) measure whether activity frequencies vary by age, and 3) test whether activity type is associated with differences in object holding. Studying everyday routines presents a methodological challenge. A single sample, even 1-2 hours long, is insufficient to detect patterns in activities that are clustered irregularly throughout the day. Likewise, using home observations precludes measuring how activities change when families are "on the go". Accordingly, we employed ecological momentary assessment by sending caregivers hourly text message prompts throughout the entire day for four days to ask caregivers to report the infant's current activity and whether the infant was holding an object. Percentage of samples reported for an activity out of total responses from that participant estimates the time spent in that activity (e.g., 15 "play" out of 30 total = 50%). We employed a cohort sequential design in which two groups of infants completed four monthly sessions. The younger cohort (N = 58) was sampled from 4-7 months and the older cohort (N = 62) was sampled from 10-13 months.

Across ages, play and napping were the most frequent categories, followed by eating/drinking and errands. All other categories comprised a small proportion of infants' daily routines. Play, eating/drinking, and reading time significantly increased with age whereas comforting significantly decreased (Figure 1). Although an increase in play from 28.2% of samples at 4 months to 35.2% of samples at 13 months might sound modest, a difference of 30-60 minutes/day (estimated based on typical waking day length) is sizable when aggregated over weeks and months of development. Changes in daily activity are consequential for understanding opportunities for learning: When comparing the likelihood of object holding conditioned on activity type, infants were most likely to hold objects while playing and eating/drinking compared with errands and all other activities (Figure 2). Moreover, age moderated this effect: Whereas both younger and older infants held objects for similar amounts while on errands, older infants held objects far more often than younger infants while eating/drinking. Taken together, these results suggest that the macro-level structure of infants' daily routines changes with age, potentially revealing differences in micro-level opportunities for engaging with objects.

P1-A-10 - Online reach correction in 7-month-old infants with the unseen hand

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Details

A recent study (Verhaar et al., 2023) reported that already at 6 to 7 months of age, infants show online control of their reaching movements. They can adjust their movement mid-flight if the goal is suddenly displaced. Here, we investigate whether this online control depends on visual information about the position of their hand.

We invited 5.5- to 7-month-old infants to the lab. They were encouraged to reach with their dominant hand for a glow-in-the-dark toy while their hand position was tracked using an infra-red reflective marker (see Figure 1). Participants (N=33; Mean age = 7m2d, SD = 1m20d; 17 girls) were randomly assigned to either the *Hand-seen* or the *Hand-unseen* group. Although for both groups, the room lights were turned off during reaching, the infants in the *Hand-seen* group had visual information about the location of their right hand by means of a glow-in-the-dark wristband, while the *Hand-unseen* group reached without a wristband. Reaches were split in baseline trials, in which the toy maintained the same position throughout the reach, and perturbation trials, in which the toy was displaced left- or rightward while the infant was reaching for it (see Figure 2).

To test whether and under what circumstances infants correct their movements online, we described the reach trajectories using an autoregression model, adapted from Saunders and Knill (2003). In this model, the position of the hand at time step t was expressed as a time-dependent linear combination of its position at time steps t-4 to t-1, plus a time-dependent offset. The coefficients of this autoregression model were fitted to the baseline trials. Subsequently, the model was compared to the leftward and rightward perturbation trials. A deflection from the model in the direction of the perturbation indicates that the trajectory differs from baseline. This difference can be understood as an online correction of the reach.

Bayesian linear mixed effects models were used to test whether hand trajectories indeed deviated from the baseline model when the toy was displaced. We found decisive evidence for a main effect of perturbation (BF10 = 203.56), indicating that participating infants controlled their reaches online, replicating the previous study. Furthermore we found anecdotal evidence against a main effect of vision (BF10 = 0.363), suggesting that wearing the wristband did not lead to general changes in the reach trajectories. Critically, the results provided anecdotal evidence *against* an interaction between the perturbation and vision conditions (BF10 = 0.42). This indicates that wearing the glow-in-the-dark wristband or not, did not matter for their ability to adjust their reaches.

We conclude that 7-month-old infants are capable of controlling their reaches in an online fashion, irrespective of whether they have their hand in view. This suggests that early online control primarily relies on proprioception rather than vision of the hand. As adults are known to use both proprioception and vision of their hand for online corrections (Keyser, Medendorp, Oostwoud Wijdenes, & Selen, 2023), future studies may focus on when in development seeing the hand is integrated into online reach control.

P1-A-11 - Early motor milestones in children with upper limb differences

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Details

Aim: Each year around 500 babies in the UK are born with a congenital upper limb difference, a term used to describe a diverse range of anomalies: from fused digits to total absence of the hand and arm. Upon finding out about their child's limb difference, parents begin to question how their child will

develop – will they crawl? Will walking be delayed? Surprisingly little is known about impact of upper limb differences on early motor development. As well as helping parents, studying this population could also provide an excellent test of the hypothesis that locomotor development is a flexible system (Adolph et al., 2018), whose paths can vary depending on individual biomechanical and social constraints. This study examines the attainment of six gross motor milestones in a large sample of children with a congenital upper limb difference affecting one hand. *Method*: Parents and carers of 92 children born with one- hand and 53 two-handed children completed a survey detailing the age at which their child achieved six key gross motor milestones: sitting, crawling, standing with support, standing independently, walking with support, and walking independently. All children were under 8 years old and had no known cognitive or motor impairments. Parents/carers were encouraged to look back at baby books and photos/videos to confirm the age of achievement. *Results*: Two milestones were no different in the two samples; two were marginally different; and two were significantly different. There were no differences in the average age at which children with a limb difference and two-handed controls were reported to sit independently (p=.14, BF_{10}=.52) or crawl on their hands and knees (p=.24, BF_{10}=.34). However, children with a limb difference employed more variable strategies for crawling: only 47% of the sample crawled on their hands and knees compared to 71% of two-handers. Commando crawling and bum shuffling were the two most common alternative strategies for crawling, with higher prevalence in children with a limb difference (24% and 21% respectively) than in two-handers (14% and 4% respectively; see Figure 1). Some precursors to walking, namely standing with support, and standing independently were found to be marginally significant (p=.05, BF_{10}=.78 and p=.057, BF_{10}=.57 respectively), emerging approximately 2 weeks later in children with a limb difference than those without. Finally, walking with support and walking independently emerged around a month later in children with limb differences (p<.001, BF_{10}=16.25, and p=.021, BF_{10}=1.29 respectively). *Conclusion*. Whilst children with a limb difference typically achieve their early milestones at the same time as children with two-hands, walking and some of its precursors develop slightly later. Furthermore, from a very early age, children with a limb difference find their own unique motor strategies – in this case crawling in specific ways to accommodate their difference. Despite diverging from the typical path of motor development, these children achieve functional end-state development by following a different path, therefore providing evidence for the theory that motor development is highly flexible (Adolph et al, 2012, 2018; Karasik et al., 2008).

P1-A-12 - Sleep on it! The influence of naps on infant's reaching decisions

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Details

When solving a taxing problem, infants will often focus their attention on one task demand at the expense of another (Berger et al., 2018). For example, novice sitters have slower looking patterns compared to experts. Experts can allocate attention to information processing while novices must allocate their attention to balance control (Harbourne et al., 2014). For novice walkers, a daytime nap and night sleep facilitated learning to solve a novel locomotor problem with competing attentional demands, whereas a night of sleep alone did not (Horger et al., 2023). Research on how sleep impacts motor performance and distribution of attentional resources in younger infants is limited. Therefore, the

aim of this study was to investigate the role of sleep in pre-crawling infants' motor problem solving. Whether sleep had a similar impact on learning for younger infants as it does for older infants speaks to changes in the function of sleep for learning over the first year.

Twenty-four typically developing 6- to 8-month-old infants (M_{age}=7.57 months; 11 female) received a modified version of Piaget's A-not-B task (1954) twice in one day, with a four-hour delay between sessions, and a third session the next morning. Thirteen infants napped during the delay and eleven remained awake. Infants had to manually search in a reaching board for a partially hidden toy which was placed at location 'A' five times but at 'B' the sixth time. Reaching to 'A' when the toy was at 'B' indicated perseveration, an inability to inhibit. Researchers used Datavyu video coding software to code extent of infants' perseveration (composite score of looking, reaching, and postural shifts), how long it took infants to reach for the toy, and balance control strategies.

A repeated measures ANOVA with session as a within-subjects factor and group (nap, no nap) as a between-subjects factor revealed a main effect of session on extent of perseveration, $F(1, 22) = 4.66$, $p < .05$) with nappers perseverating more than non-nappers (Figure 1a). A 3 (session) x 2 (trial) repeated measures ANOVA with group as a between-subjects factor revealed a significant trial x condition interaction for trial duration, $F(1, 22) = 4.13$, $p = .05$, significant session x condition and session x trial interactions for balance control strategies, $F(1, 22) = 5.89$, $p = .04$, and $F(1, 22) = 6.49$, $p < .02$, respectively (Figure b-c). The no-nap group took longer to reach and had more balance control strategies on the B trial than both groups on the A trial and the nap group on B.

That the nap group perseverated more than the no-nap group evokes a previous study showing that advanced sitters perseverated more than novice sitters because the novices' instability prompted them to reduce balance demands by leaning on support (Berger at al., 2019). Perhaps the no-nap group's fatigue led to increased instability, which prompted them to slow down and attend to balance control, ultimately making the task easier. Alleviating attentional demands may be more important for infants' inhibition than sleep.

P1-A-13 - Reaching out of the comfort zone: Late preterm infants slow down to complete A-not-B task

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Details

Infants born late preterm (34-37 weeks gestation) achieve major developmental milestones at or near their corrected age. However, they are known to be at higher risk for delays that only become apparent as they reach school-age (Morse et al, 2009). Very early skills such as sitting, reaching, and looking to explore objects in the first year may lay the foundation for strategies that later contribute to a risk for overall delay (Caravale et al, 2005; Stewart et al, 2019). Our purpose was to create a scenario where infants would have to control multiple factors: control sitting posture, reach to a target, and select an appropriate response to reach to a changing target. We utilized the A-not-B paradigm to challenge newly sitting infants. We hypothesized that late preterm infants would show subtle differences from full-term infants in strategies or timing in this task for looking, reaching, or postural control.

Forty 6- to 8-month-old infants (24 FT, 11 girls, M_{age} =7.57 months old, SD=.52; $M_{SittingExperience}$ = 1.57 months, SD=.8; and 16 moderate-to-late PT, 10 girls, M_{age} =7.94 months old (corrected age), SD=1.17; $M_{SittingExperience}$ = 1.31 months, SD=.75) able to sit independently but not yet crawl participated. Infants sat on a pliant foam surface to challenge their ability to keep balance during a reaching task. In this task, an experimenter hid a toy at one location in a reaching board 5 consecutive times ('A' trials) followed by once at another location ('B' trial). Primary outcomes after the switch were composite measures of extent of *perseveration (*looking, reaching behavior, body direction shifts to the wrong location); and *balance* control strategies (falling, leaning on arm, high guard posture to stabilize trunk), as well as trial *duration* (how long it took to complete the trial).

A series of repeated measures ANOVAs with trial as the within-subjects factor and group as the between-subjects factor revealed no main effects or interactions for extent of perseveration; a significant main effect of group for balance control strategies, F(1,38) = 5.54, p= .024 (Figure 1b); and an interaction between trial and group for trial duration, F(1,38) = 5.13, p= .029. Post hoc Bonferroni tests confirmed that trial duration was significantly higher for the PT than the FT group on the 'B' trial (Figure 1c).
Infants born prematurely may need more time to process information than infants born at term. PT infants were able to inhibit as well as FT infants, but they took longer to inhibit reaching to the wrong location after the toy switched locations. PT infants' use of more balance control strategies than FT infants suggests that resources must be allocated to one motor task (maintaining sitting) which may siphon attention away from looking and reaching to the new location. Initial, subtle differences in attention allocation may accumulate to emerge as meaningful delays by school-age. Small differences in speed of the preterm infants' performance suggests that early infancy may be the optimal time to measure and track timing and allocation of resources to intervene well ahead of school entry.

P1-A-14 - Moving more, sleeping less: Learning to walk disrupts infants' sleep

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Details

Infants' sleep becomes more fragmented around the acquisition of new motor skills. Crawlers have higher rates of sleep-related difficulties than age-matched pre-crawlers, such as requiring more parental involvement to fall asleep or waking up multiple times during the night (Scher, 2005; Scher & Cohen, 2015). A recent longitudinal, daily diary case study of three infants showed that changes in night wakings and night sleep duration were temporally linked to the onset of several motor skills (Berger & Moore, 2021). Key limitations have been small sample size, cross-sectional design, and subjective parent report of infant sleep. This project is the first to document how infants' milestone onsets shape the quality of their sleep on a large scale using prospective parent reports of developmental milestones and auto-videosomnography, an automated, non-invasive, objective quantification of infants' sleep that is as accurate as and less intrusive than actigraphy and more accurate than parent report (Horger, et al., 2021).

For this abstract we present a subset of data from a larger, ongoing, longitudinal study examining the relation between infants' sleep quality and motor development over the first year of life. We focus on the transition to walking, both **first walking steps** (<10 feet) and **mastery of walking** (>10 feet). To document skill onset, parents (n=124) responded to a daily prompt via an app asking whether they had observed their infant perform a set of skills. Auto-videosomnography documented infants' sleep via an infra-red camera mounted over the crib. Users defined the crib area in the paired app. Based on activity level in each pixel of the crib video over the course of the night, a computer vision algorithm coded for *sleep characteristics* reflecting overall quality of night sleep (night wakings, sleep efficiency [percent of true sleep from the total sleep period]; and *parental visits*.

A changepoint analysis on all sleep metrics for first walking steps and for walking mastery tested whether infants' sleep was disrupted on or near the nights of skill onset. Changepoint analyses search for abrupt mean changes in times series data. We calculated the within-subject mean of each sleep metric over 32 nights on which there was no milestone onset (16 nights on either side of onset) and the deviation for each sleep metric on each night compared to the within-subject mean. Finally, changepoint analysis analyzed these deviations to identify changes within infants' nightly sleep metrics compared to the within-subject mean.

First walking steps did not change infants' sleep (Figure 1). However, cumulative sums of deviations of sleep metrics exceeded the thresholds on various nights surrounding mastery achievement. Changepoints were detected for *sleep efficiency* (3 days before, 1 day after mastery onset; Figure 2) and *night wakings* (15 days before, 8 days after, 13 days after, 15 days after mastery). Changepoints to sleep metrics, but not parent behavior demonstrate that parents are not always cognizant of meaningful changes to their infants' sleep. Skill-dependent patterns suggest that the underlying relation between sleep and walking onset is the long-term consolidation of information, rather than skill preparation.

P1-A-15 - The prevalence and profiles of repetitive behaviours in infants with neurodevelopmental conditions: A meta-analysis

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Details

Background: Repetitive behaviours are rhythmic stereotyped behaviours that usually occur in early infancy and toddlerhood as a mode of sensorimotor adaptation (Piaget, 1967) in typically developing populations. There are different classifications of repetitive behaviours, namely 'lower-order' behaviours (typically repetitive motoric behaviours such as hand flapping or rocking) or 'higher-order' behaviours (ritualistic behaviours, insistence of sameness; Cuccaro et al., 2003; Bishop et al., 2006; Turner-Brown et al., 2011). Whilst there has been substantial research conducted into the processing and phenomenology of repetitive behaviours in typically developing infants, less is known about the

differences in these factors in infants with neurodevelopmental conditions. Research that has been conducted within the field of neurodevelopmental conditions often reports high prevalence rates of repetitive behaviours, specifically in autistic populations (Boyd et al., 2010; Purpura et al., 2017; Chaxiong et al., 2022) and in populations with genetic syndromes (Woodcock & Humphreys, 2008; Moss et al., 2009; Waite et al., 2014). However, despite this, these putative differences in repetitive behaviours have not been synthesised quantitatively in different neurodevelopmental conditions, rather the field has focused on singular neurodevelopmental conditions in contrast with typically developing populations.

Purpose: Due to this lack of comparison between different neurodevelopmental conditions, the main aim of the meta-analysis will be to describe any differences in the prevalence and profiles of repetitive behaviours that have been reported in the literature. Synthesising pooled prevalence estimates could help with bettering understanding of the differences in frequency and presentation of repetitive behaviours in different neurodevelopmental conditions. Additionally, infancy data and consequently lower order repetitive behaviours are rarely included in reviews. The identification and inclusion of these data will improve developmental understanding of repetitive behaviour and if data permits, be compared to papers that include higher-order behaviours on a trajectory scale. In this poster, I will present the findings of a meta-analysis that aims to explore the prevalence and profiles of repetitive behaviours in neurodevelopmental conditions within the current literature.

Method: A systematic search will be conducted by two independent researchers to achieve reliability. Pooled prevalence estimates will be analysed for three different neurodevelopmental condition sample groups: an autistic sample group, a sample group with intellectual disability, and a sample group with genetic syndromes. Papers that report on ages from infancy until 17 years will be included and the development of repetitive behaviours will be compared over the ages

P1-A-16 - An investigation of infants' body lateralization and goal-directed behaviors during early pulls-to-stand

Sabrina Thurman [1], **Rebecca Rose** [1]

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Details

Pulling to stand (PTS) is an important transitional posture that bridges the gap between crawling and walking and provides new opportunities for infants' learning and interaction (e.g., reaching higher objects, seeing caregivers better, etc.). However, it is unclear how infants learn to use specific lateralized movements of their hands or feet to pull themselves upright or how their hand and foot use may relate to their goals post-PTS. Here, we ask, how do infants' use lateralized sides of their bodies during PTS, how do these movements relate to their post-PTS goals, and how do these behaviors change as infants learn to walk? We tracked changes in 13 infants' PTS behaviors longitudinally in biweekly 10-minute laboratory free play sessions across a ~2.5-month period from crawling to walking. For each PTS, we video-coded infants' hand and foot use patterns as they used their body to pull themselves upright (e.g., right hand pulled up first then left followed, or left foot pushed down on the floor while the right followed), and the infants' next behavior post-PTS (e.g., reaching for an object on the right). Laterality

quotients (LQs) for infants' hand and foot use were calculated for each session. LQs range between -1.0 suggesting a left-side bias and +1.0, suggesting a right-side bias. Results revealed over the transition from crawling to walking, infants' average LQs mostly hovered between +0.25 and -0.25, suggesting infants' early PTS were not highly lateralized. Wilcoxon tests revealed that there were not significant changes in infants' hand and feet LQ scores from pre- to post-walking sessions (hands p=.075, feet p=.917), suggesting minimal changes over time. When it came to the concordance between infants' lateralized hand and foot use, Pearson correlations revealed that hand and foot use were not significantly correlated during pre-walking sessions (p=.762), but became more similar as infants gained walking skills (p=.002). We also examined how infants' hand use during PTS related to infants' post-PTS behavior. Wilcoxon tests showed that infants were more likely to begin their PTS by pulling up with the same hand they used for their post-PTS behavior (p=0.011; e.g., an infant began pulling up with the left hand and then once upright, also reached for a toy on the left side). In addition, infants were more likely to end their PTS with their hand free on the same side of their post-PTS behavior (p=0.028; e.g., ending a PTS with the right hand free to interact with the mother on the right side). Overall, infants seem to use alternate sides of their body in similar ways during PTS, but the use of lateralized hands and feet become increasingly parallel to one another with gains in walking experience. Further, infants seem to engage in full body pre-planning behaviors before or during their PTS, as their hand and foot use is related to lateralized sides of engagement with the environment after they PTS. Infants' PTS seem to show strategic whole-body planning behaviors for future actions following PTS, which could have implications for cognitive development.

P1-A-17 - Getting the proper grip: Longitudinal study on how infants learn to adapt action plans

Tommaso Ghilardi [1], **Rachel Keen** [2], **Ori Ossmy** [1]

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Details

Across ages and cultures, planning is a hallmark of human intelligence and a critical factor in human survival and everyday function (Keen, 2011). Because everyday environments are variable and full of novel situations, performing the same actions over and over is not an option, and actors need to learn to modify even the most basic and automatised actions (e.g., reaching) to suit the current demands (e.g., object orientation). To deal with this endless stream of learning tasks, humans must master the ability to adapt their planning by assembling appropriate solutions to new problems in real-time (Ossmy, Kaplan et al. 2022).

How do we learn to adapt our plans? By using creative motor problems (e.g., tool use) in cross-sectional studies, researchers established that planning begins in infancy (McCarty, Clifton et al. 1999) and improves with age and experience (Wunsch, Henning et al. 2013). For example, when adults use a tool and the handle points toward their non-dominant hand, they adapt their habitual plan by using an underhand grip with the dominant hand to keep the action end toward their thumb. In contrast, infants in these situations rely on their habitual overhand grip with the dominant hand (Keen 2011), and find themselves in a maladaptive tool-use position (with thumb away from the tool head), and resorting to clumsy and inefficient online error corrections.

Although this cross-sectional approach is beneficial to identify adaptive planning skills or lack thereof, it is limited in explaining how developmental improvements in planning occur. Do infants first learn to

adapt their planning with one tool before generalising this skill to other tools, or does their vast and varied daily experience lead to immediate generalisation? Does this adaptability appear suddenly and remain consistent or is there variation among tools in its emergence? Only repeated, dense data collection on the same children can address those questions.
Here, we tested how infants plan their tool use with 6 familiar (e.g., spoons) and unfamiliar (e.g., magnets) tools. Nine infants were tested repeatedly between 7 and 26 weeks, with a median of 18 weeks (total of 3,804 trials). Infants were presented with various tools in each session and we scored whether they applied an habitual or adapted, adult-like grasp when the handle of the tool pointed to their non-dominant hand. We also asked infants to use some of the tools towards different targets (e.g., themselves or others). Using pattern-mixture and growth-curve models, we show that infants first master planning of the most experienced action—spoon towards themselves—and later generalise the plan to all other tools and targets. We also characterise the consistency of planning adaptability by tracking the developmental trajectory of this emerging skill.
Our findings provide intriguing insights into how adaptive planning emerges in infants, suggesting that infants need to first establish a single, familiar action to serve as a foundation for generalisation of planning to other contexts. Our findings also have implications for our understanding of how mental representations during planning become stable over infancy and the role of experience in this process.

P1-A-18 - Caregiver strategies in the development of chopstick use by young Chinese children

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Details

For close to a third of the world's population, children learn to use chopsticks as their primary tool for eating. During early childhood, children have repeated opportunities to practice the skill during mealtimes when caregivers are present. Caregivers assist infants in acquiring this skill, which may involve providing verbal and/or physical assistance during meals. Our previous studies have shown that even by 21 months of age, Chinese children successfully feed themselves with chopsticks. However, there is still limited knowledge about how caregivers assist children in acquiring this ability. In this study, we investigated how Chinese caregivers support their children in mastering the skill of chopstick use and how Chinese children gradually gain independence in using chopsticks during mealtime.

We videoed 38 children (ages 21- to 78-months-old; 25 girls) and their families during mealtimes in Guiyang, China. In all cases, children were given adult-size chopsticks by their caregivers, even at the youngest ages of children that we observed. Caregiver strategies were coded from video clips by using Datavyu (www.datavyu.org). We coded whether caregivers provided any physical, verbal, or a combination of both during food transport. Strategies were further categorized into hands-on guidance (e.g., holding the child's hand while they were engaging in food transports), regulatory language (e.g., "Align your chopsticks!", "Hurry up and eat!", "Eat!"), serving assistance (e.g., caregiver transferring food from serving plates to the child's personal bowl), encouragement (e.g., "There you go!", "Great

job!", "That's right!"), attention-getting gesture/language (e.g., pointing food/chopsticks, "Look at this!", "Here!", "Here you go!"). Inter-observer reliability for each of these variables was high (ICC= .79-.93, ps < .001).

Results indicated that, caregivers were more likely to support younger children's eating effortscompared to those of older children in terms of hands-on guidance (β = -0.0044, SE = 0.0006, z = -7.410, p < 0.001), serving assistance (β = -0.0011, SE = 0.0003, z = -4.082, p < 0.001), regulatory language (β = -0.0013, SE = 0.0002, z = -6.414, p < 0.001), and encouragement (β = -0.0013, SE = 0.0003, z = -4.836, p < 0.001), even after controlling for the total number of food transport events. Specifically, caregivers employed hands-on guidance, primarily with children aged 21 to 47 months (see Figure 1). In the case of serving assistance (see Figure 2), regulatory language, and encouragement, caregivers employed these strategies more often with younger compared to older children. In contrast, caregivers rarely used attention-getting gesture/language, with only 3 food transport events coded, involving three children at the ages of 21, 30, and 46 months.

Our findings suggest that even though caregivers in this sample in China naturally provided their children with adult-size chopsticks, caregivers scaffolded the development of chopstick use in their young children through both manual and verbal means.

P1-A-19 - Protective and risk factors on child development: longitudinal assessment of early childhood in Northeast Brazil

Simone Farias-Antúnez [1], **Elisa Rachel Pisani Altafim** [2], **Eleonora Pereira Melo** [3], **David Augusto Batista Sá Araújo** [3], **Shamyr Castro** [4], **Luciano Correia** [4], **Marcia Castro** [5], **Marcia Machado** [4]

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Details

The COVID-19 physical isolation, imposed to contain the virus spread, increased the number of children exposed to known risk factors for childhood developmental delay (poorer socioeconomic status, stimulation, and family environment). In the present study carried out in the Northeast of Brazil, children (n=294) aged 12, 18, and 24 months showed overall developmental scores worse than the expected mean with an improvement at the latest assessments (p<0.001). Motor and cognitive development domains showed the best and worst scores, respectively. Girls and children of mothers with education >8-years had better overall developmental scores. Although no income differences were observed, children participating in visitation programs (more vulnerable) had worse scores at 24 months. Results highlight the importance of policies promoting children's early stimulation from birth, especially in low-income settings.

P1-A-20 - Sloping shoes and sloping ground: Body-environment relations in infant walking

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Details

Walking, like any action, depends on the "fit" between body and environment. Either side of the equation can disrupt walking, but these disruptions can either be voluntary and prospective (gait modifications) or involuntary and reactive (missteps and falls). Slippery shoes and slippery ground, for example both disrupt walking by requiring gait modifications to normal walking patterns (e.g., smaller, slower steps) or by causing walkers to misstep and fall. Infant walkers are more disrupted by changes in the body and the environment compared with adults, but infants must learn to walk with a changing body in a changing world nonetheless.

Here, we are testing infants (11 to 20 months of age) with varied durations of walking experience (< 1 month to > 6 months) in counterbalanced comparisons of body vs. environment: (Figure 1A) a "baseline" condition where infants walk on flat ground in flat shoes; (Figure 1B) a "body" condition where infants walk on flat ground wearing wedge shoes with a 10° downward slant; (Figure 1C, 1E, 1I) three "environment" conditions where infants walk down or up sloping ground; and (Figure 1D, 1F, 1H) three "body-environment" conditions where infants walk down or up sloping ground while wearing the wedge shoes. Infants walk 5 times in each condition. For each trial, we calculate the number of steps and time to walk the length of the platform (90 cm) as a proxy for average step length and step time, and the number of missteps (trips, back steps, and falls).

To assess the extent to which infants' walking is disrupted, we compare their performance in each body, environment, and body-environment condition to baseline. We also test effects of body and environment in four paired comparisons, where the conditions are putatively equivalent (Figure 1). Comparison 1 tests whether walking in 10° wedge shoes is equivalent to walking in flat shoes down a 10° slope (both manipulations tilt the feet downward 10°). Comparison 2 tests whether walking in 10° wedge shoes down a 10° slope is equivalent to walking in flat shoes down a 20° slope (both manipulations tilt the feet downward 20°). Comparison 3 tests whether walking in 10° wedge shoes up a 10° slope is equivalent to walking in flat shoes over flat ground (both manipulations keep the feet level). Comparison 4 tests whether walking in 10° wedge shoes up a 20° slope is equivalent to walking in flat shoes up a 10° slope (both manipulations tilt the feet upward 10°).

We expect more disruptions to infant walking in each body, environment, and body-environment condition relative to baseline, especially in less experienced walkers. Most importantly, differential effects of body vs. environment in the four comparison tests will reveal whether changes in the body or the environment are more disruptive to infant walking at various points in early locomotor development. Results will reveal new insights into the body-environment interactions that may influence infants' deliberate decisions to adapt their walking prospectively (gait modifications), and involuntary and reactive alterations to walking (missteps, falls).

P1-A-21 - Evaluating face detection algorithms on a unique head-mounted camera dataset of young children with and without Down syndrome

Teodor Nikolov [1], **Tamas Foldes** [1], **Ziye Zhang** [1], **Yu-Kun Lai** [1], **Hana D'souza** [1]

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Details

Introduction: Young children actively construct their visual curriculum for learning via moving their eyes and bodies. Very little is understood about how this process is constrained in young children with neurodevelopmental conditions, who often experience attentional and motor difficulties early in life. Providing technology for practitioners (e.g., speech and language therapists, physiotherapists) that would enable them to glean neurodivergent children's everyday visual experiences, would transform the landscape of early years support. A key step towards this goal is making the data annotation process automatic, and thus scalable. Here we focus on some of the most developed automatic annotation tools – those used for face detection. The aim of the current study is to investigate how well existing face detection algorithms deal with a unique head-mounted camera dataset we are currently collecting from young typically developing children as well as young children with a neurodevelopmental condition associated with attentional and motor difficulties – Down syndrome. This dataset presents a unique set of challenges: the presence of unusual angles, occlusions, blurry images, and the dynamic nature of children's activities, which are rarely encountered in standard face detection benchmarks.

Method and Preliminary Results: We used head-mounted camera video recordings (total duration: 60min 49sec), captured within the natural domestic environment of the home of one typically developing child (18 months) and extracted one image per second (3,649 images in total). Three human annotators labelled each image for the presence of at least one face (yes/no). The criterion for assigning a label to each frame required 2 out of the 3 annotators to agree. This resulted in the identification of 181 frames containing human faces. We evaluated the efficacy of leading face detection algorithms in accurately identifying faces within this dataset by utilising the DeepFace Facial Recognition Library with default parameters and thresholds: OpenCV, MediaPipe, Dlib, SSD, MTCNN, RetinaFace, YuNet, and YOLOv8Face. The results showed that MTCNN, RetinaFace, and YOLOv8Face outperformed the rest (see Figure 1). While images that were mislabelled by the algorithms as having a face included toys, frames with faces which were missed mainly included an occluded or obstructed human face. Please note that we are currently collecting more data which will be included in the final poster.

Discussion: These results indicate that detectors, such as MTCNN, RetinaFace, and YOLOv8Face, perform very well, even without being specifically trained on our dataset. This suggests the potential of these detectors to be used alongside or instead of manual annotation. We aim to fine-tune the models by adjusting detection threshold parameters and to refine the best-performing detector by fine-tuning it with an expanded dataset as more data becomes available. This iterative approach underscores the synergy between computer science and developmental science, showcasing the transformative potential of machine learning in supporting complex neurodevelopmental conditions. The insights derived from this research are expected to contribute significantly to creating individualised support that bolsters the learning and development of children with Down syndrome and other neurodevelopmental conditions, affording them optimal opportunities to navigate and interact with the world around them.

P1-B-22 - An early stimulation program for manual skills: a pilot study

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Details

Manual skills are a fundamental tool for infants to explore the world, communicate, and express their desires. Acquiring manual skills at an early age afford infants opportunities to explore regularities in their encounter with the world even before being able to show independent instrumental use of reaching and grasping. However, caregivers at home and in early infant care centers are not aware of the need for promoting fields of action for young infants to their hands in actions even before they are instrumental. The aims of this study were to offer a program to stimulate early manual skills in infants from 1 to 3 months old during daily care practises; to measure the mothers' adherence to the program; and to describe the beliefs about motor development of the mothers who applied to the program. 4 dyads of mothers and their infants participated (= 3.5 weeks old, sd= 0.5). Before starting the 8-week program and after finishing it, the General Movements (GM) scale was used to evaluate infants' motor development. Mothers had access to a closed Instagram profile with video clips describing the stimulation activities in the following categories: manipulation, sensorial massage, auditory contingency and accidental touch, that should be done during bath, diaper changing, sunbath, and breastfeeding. Adherence to the program was obtained by a questionnaire sent daily to the mothers. Also, mothers answered the Parental Beliefs on Motor Development (PB-MD). The results show that infants received = 58 days of stimulation (sd=11.31) during 8 weeks. The activities were most offered during diaper changing (= 25.5, sd= 2.5 times), followed by breastfeeding (= 18, sd= 13.21), sunbath (= 16.25, sd= 8.30), and bath (= 15.5, sd= 11.6). The number of repetitions per day was 1-2 times/day (= 13.5, sd= 12.3); 3-4 times/day (= 7.7, sd= 8.0); 5-6 times/day (= 6,25, sd= 5,9); 7-8 times/day (= 2.5, sd= 4.3); 9-10 times/day (= 2.2, sd= 4.5). The total hours of stimulation for each participant were as follows: participant 1 (10.16h), participant 2 (3.46h), participant 3 (4.7h) and participant 4 (0.8h). The PB-MD showed that 100% of mothers considered motor development one of the most important thing in the first years of life, 50% believed that motor development needs stimulation, and 25% believed that it does not. No mothers believed that the milestone must be reached as soon as possible, and all mentioned that infants do not need tummy time and especially if they cry. The infants showed independent reaching between 7-8 weeks old. The results show that regardless of individual dyadic differences, all mothers adhered to the stimulation activities during daily care practices. Even though the stimulation did not anticipate the achievement of reaching milestone, young infants had the opportunity to use their hands to explore objects and contingent relationships through the stimulation program. Informing parents of this practice can improve child rearing practices for typical babies, and this can be an early intervention tool for at-risk infants.

P1-B-23 - Examining profiles of early social and emotional support experience and developmental outcomes: A group-based multi-trajectory model analysis

Samantha Burns [1], **Zhangjing Luo** [2], **Michal Perlman** [1]

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Details

Early childhood is a critical developmental period. During this period children spend most of their waking hours in some form of early childhood education and care setting (ECEC). Emerging research suggests that measures taken at levels that require aggregation across the experiences of individual children with different educators masks important variation that can occur across levels (e.g., classroom, educator, child) or time (e.g., throughout the morning). This study is the first to examine the variation in the quality of social and emotional support across children, measured across six time points, over the course of a morning. To do so, this study employs a novel 'person centered' longitudinal analysis, a group-based multi-trajectory model analysis (GBMT), to examine how the social and emotional supports educators provide and children receive changed across a morning. A total of 94 classrooms and 610 children were included in this study. Results found that very few children (22% - 34%) received interactions from their educator with 10% to 21% of children (Figure 1). GBMT analyses found three subgroups of children based on the frequency of interactions they experience and how that frequency changes over time (Figure 2): None to Some (37%), Decreasing Quality (29.7%), and Consistently Low (33.3%). Children who were in the Consistently Low profile were more likely to not speak English as their first language at home, have higher levels of hostility, and had lower scores on considerateness than those who experienced decreases in quality across the morning. Implications for policy, practice, training, and future research is discussed.

P1-B-24 - Contents and characteristics of virtual home visits for families of infants and toddlers

Lorraine Mckelvey [1], **Kanna Lewis** [1], **Nicola Edge** [1], **Shalese Fitzgerald** [1]

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Details

The quick shift of home visiting (HV) programs to a virtual platform due to COVID-19 left a gap in knowledge as to whether such practice meets fidelity and results in comparative effectiveness as in-person visits. Given the evidence that deviations from fidelity diminish program effectiveness (Casillas et al., 2016), it is important to document whether virtual delivery may compromise the benefits of HV for at-risk families. No known studies have examined the effects of delivery mode on HV retention and contents. This study aimed to examine whether the enrollment length and contents of HV differ based on the primary delivery method (in-person, phone, video).

A retrospective cohort consisted of 1131 families who enrolled in an evidence based HV services from March 2020 to December 2022. HV models included Healthy Families America (HFA), Home Instruction for Parents of Preschool Youngsters (HIPPY), and Parents as Teachers (PAT), which were offered at a total of 28 sites. The primary exposure is a categorical variable indicating the primary delivery method of HVs (in-person, phone, or video) during the first one, three, and six months of services. The HV content examined include parent-child interaction, child development, and staff-family relationship building activities. In each period, generalized linear integrated mixed models for the time spent on each content area was fitted to assess the impact of phone and video visits compared to in-person visits. An indicator for each program site was included in the mixed models as a random effect. Covariates included the date of enrollment, child age category (<1, 1-2, 3-4 years old), gender, and race and ethnicity. Length of

enrollment based on the delivery mode in the first month of enrollment was similarly examined. Most families received services throughout the observation period in the same primary delivery method that was used within the first month.

Table 1 summarizes the demographics overall and by the first month primary delivery mode. Compared to in-person delivery, phone visits included less time focusing on parent-child interactions in all observation periods. Video visits in first three and six months were significantly associated with less time spent focusing on child development. In the first month of enrollment, phone visits included less time spent on staff-family relationship building activities compared to in-person visits. Finally, a family's primarily receiving video visits in the first months of services was associated with a longer enrollment length compared to in-person visits.

HV continued to serve an important role for the wellbeing of at-risk families during the pandemic (Williams et al., 2021). The findings indicate that phone and video visits had distinct and significant effects on the content of HV for families with young children, who started services during this period. The first months of program participation is important for relationship and expectations building (Barton et al., 2020). A future investigation on the HV effectiveness and benefits due to the change in delivery methods and the focus contents is needed. Our study also suggests that video visits may lead to a longer retention of families.

P1-B-26 - The Infant and Toddler Curiosity Questionnaire - Dutch version: a translation and validation study

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[1] Radboud University Nijmegen

Details

Over the past few decades, curiosity has received considerable attention in infancy research, with various theories and frameworks proposed to define and explain this multifaceted concept (e.g. Berlyne, 1954; Loewenstein, 1994; Oudeyer & Kaplan, 2007; Litman, 2008). Despite these efforts, until recently, an instrument assessing the behavioral expression of infant curiosity during everyday life was lacking. Altmann and colleagues (study in progress, AsPredicted: 80828) addressed this gap by developing the Infant and Toddler Curiosity Questionnaire (ITCQ), a parent-report instrument measuring infants' general curiosity across the age range of 5 to 24 months, unconstrained by specific theoretical frameworks.

So far, this novel questionnaire has only been available for English-speaking caregivers. In the current study, we aimed to broaden the scope of this curiosity assessment tool to Dutch-speaking communities, by translating the ITCQ into Dutch and assessing its psychometric properties (reliability and validity) with a sample of Dutch caregivers. This study was preregistered (see osf.io/s4gb9). The translation involved a rigorous forward-backward process, and item clarity was evaluated among ten pilot participants. Participants of the validation study (n=341, 47% female, mean age = 16.4 months, SD=5.6), see Figure 1 for spread of age) completed the ITCQ-Dutch along with Rothbart's Temperament Questionnaire

(Putnam et al., 2014; 2010) and demographic inquiries to establish reliability and validity. A subset completed the ITCQ-Dutch a second time after a two-week interval to assess test-retest reliability. Ongoing data analysis includes assessments of internal consistency (Cronbach's alpha), test-retest reliability (Intraclass correlations (ICC), and construct validity. Validity is evaluated by correlating (Pearson's R) the ITCQ-Dutch mean score with two questions explicitly asking about the parent's perception on their child's curiosity and three temperament scales from Rothbart's Temperament Questionnaire (Surgency, Negative affect/Emotionality, and Effortful control/Regulatory capacity). Results of the analysis will be presented.

The overarching goal of this study is to create and validate a questionnaire that captures the everyday behavioral manifestation of infants' curiosity, as perceived by their caregiver(s) in the Netherlands. The resulting curiosity score holds potential for comparing different infant groups and the identification of factors that contribute to individual variations in this trait. In our ongoing research, we anticipate the questionnaire to contribute to our understanding of curiosity in two main ways. First, we plan to relate the questionnaire with previously employed instruments assessing curiosity-driven learning, seeking to bridge the gap between experimental paradigms and observable behaviors. Second, in collaboration with the developers of the ITCQ and other researchers, we are working on the development of a similar questionnaire tailored for children aged 2 to 5 years, enabling an exploration of curiosity trait stability and insights into the developmental trajectory of curiosity across early childhood.

P1-B-27 - Ensuring high quality child care: Evaluating the implementation of new universal child care program with machine learning

Esther Yu [1], **Samantha Burns** [1], **Maisha Masum** [1], **Melissa Sariffodeen** [1], **Isobelle Chen** [1], **Michal Perlman** [1]

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Details

The increasing exposure of infants to early childhood education and care (ECEC)[1, 2] coupled with significant governmental investment[3], underscores ECEC's importance in public policy[4]. Research has shown that high-quality ECEC fosters language, cognitive, and socio-emotional development in young children, particularly benefiting children from low-income families[5–11]. In Canada, the federal government has invested 30 billion dollars to reduce childcare costs to around $10 a day by 2026, referred to as the Canada-Wide Early Learning and Child Care (CWELCC). Quebec was the pioneer in implementing such a policy in Canada. However, with the rapid expansion of the program to meet demand, consistently maintaining high-quality care can be challenging[12]. Specifically, this addressed the following questions: (1) What are the specific ECEC quality aspects prioritized by the Canadian provinces and territories (P/Ts); (2) How frequently is ECEC quality discussed in CWELCC documents across P/Ts; and (3) What topics of quality are identified using a machine learning (ML)-based natural language processing model.

To address these questions, we analyzed the CWELCC 2021–2026 policy documents for 12 Canadian provinces and territories (except Quebec due to its inconsistency in reporting format) using the

following traditional and novel methodological approaches. First, thematic analysis[13] was conducted by having a team of researchers collaboratively identify and group overarching themes within and across the policy agreements. Second, a content analysis was conducted to assess the frequency of ECEC quality key terms (e.g., "professional development," "equipment," "license"). Third, to offer a novel perspective, topic modelling using Latent Dirichlet Allocation (LDA)[14] was performed in Python on each P/T document to uncover themes related to ECEC quality. Quality key terms were identified in the text, and 50 characters before or after the term were extracted and used in the LDA model for topic modelling.

The thematic analysis found five main themes of quality prioritized during CWELCC: (1) Staffing Issues, (2) Professional Development Opportunities, (3) Structural Quality, (4) Educator Wages, and (5) Curriculum Developments. The content analysis revealed clear variation in how frequently each P/T discussed quality. The five-topic LDA model found substantial overlap with human coding. For example, some LDA-generated topics are composed of terms like “wage,” “recruitment,” “training,” and other terms related to the Staffing Issues theme. While some P/Ts focused on staff professional development, others prioritized creating inclusive, quality ECEC for diverse populations. Interestingly, LDA output included more nuanced details that were not found in manual coding, such as detecting terms like “indigenous” and "indigenous-led." This could suggest that having indigenous-inclusive quality child care is different from having ECEC services that are indigenous-led. Implications for research and future policy are discussed.

P1-B-28 - Comparing the use of Individual versus Age-specific MRI Templates during MRI co-registration in Infant fNIRS Analysis

Giulia D'avino [1], **Samuel Forbes** [1], **Sobana Wijeakumar** [2], **Vincent Magnotta** [3], **Sean Deoni** [4], **Vinay Singh** [5], **Madhuri Tiwari** [5], **Aarti Kumar** [5], **John Spencer** [6]

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Details

Functional near-infrared spectroscopy (fNIRS) is a novel and innovative neuroimaging technique which uses near-infrared light to measure changes in haemoglobin oxygenation in the brain. This technique is useful when investigating brain development in infancy as it allows infants to move freely. It is also low-cost and portable which is especially crucial when collecting data in low-resource settings. However, a major issue with fNIRS is the need to spatially localise the signal in the cortex. One approach to overcome this is co-registration with magnetic resonance imaging (MRI, also referred to as image reconstruction) to gain structural information in analysis. Typically, co-registration uses an atlas – a brain template created from a population of infants – but it can also be used with individual anatomy (e.g., a participant’s MRI scan). Yet, little research has compared the use of individual versus template anatomy in infant fNIRS analysis.

Our study aimed to rectify this by running 4 different analyses on the same data from a sample in India. A total of 142 participants, 72 6-month-olds and 70 9-month-olds, took part in an fNIRS session with a visual working memory preferential looking task and an MRI session in the Raebarelli district of Uttar

Pradesh, India. The co-registration analyses were run using the analysis pipeline by Forbes et al (2021) and the channel-based analysis followed a similar protocol but without co-registration. First, a channel-based analysis (using only the fNIRS data) was run as a baseline analysis. Second, an analysis reconstructed with participants' individual MRIs was conducted. The third and fourth analyses were run with an age-specific template developed from an Indian sample (same cohort as participants) and an age-specific template from a United States (US) sample (Dean et al, 2014).

Findings show that the analysis with age-specific templates, both India and US, found the most significant clusters ($p < .01$), followed by the individual MRI analysis and lastly, the channel-based analysis. Additional analyses were run to further explore the results. This included decreasing the cluster size to 105 voxels (a less conservative threshold) and investigating brain tissue properties. We found that the templates had double the number of clusters than the analyses conducted using individual MRIs (Figure 1). When examining the brain tissue properties, we found that both templates had more grey matter (GM, orange arrows in Figure 2) and less skull (red arrows in Figure 2) and the individual MRIs had more skull (black arrow in Figure 2). This is meaningful for fNIRS research as the different properties may lead to differences in fNIRS signal strength during image reconstruction. In particular, the combination of more GM and less skull in the templates pushes the fNIRS signal deeper into the brain allowing the signal to spread, leading to more significant clusters. The skull absorbs near-infrared light; consequently, the presence of more skull in the individual MRIs may reduce signal strength leading to fewer significant clusters.

This work shows how various analysis approaches may lead to differing results, suggesting the need to converge on a standardised approach in infant fNIRS analysis.

P1-B-29 - ORICL: A co-designed method to support educators and enrich infants' experiences in education and care settings

Linda Harrison [1], **Sheena Elwick** [2], **Sandie Wong** [1], **Magdalena Janus** [3]

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Details

OBJECTIVE. The provision of consistent, high-quality pedagogy and practice for children under 3-years is a significant challenge for the early childhood education and care (ECEC) sector in Australia and many other countries. Across all qualification levels (degree, diploma, certificate) ECEC educators report not receiving enough training on the developmental and pedagogical needs of infants and toddlers, and limited access to professional development supporting them to provide quality experiences for this age group. This presentation describes a new method, the Observe Reflect Improve Children's Learning (ORICL) tool, that addresses this gap.

METHOD. Applying principles of implementation science, ORICL was co-designed in collaboration with ECEC professionals and practitioners as a new method that aimed to enhance the capacity of educators to notice, record, and interpret the day-to-day interactions, relationships, and learning experiences of very young children in ECEC settings. Generated through a sequence of co-design steps, the ORICL tool has 118 stimulus items that describe children's behaviour and interactions across six domains that

illustrate, in user-friendly accessible language, the Learning Outcomes of *Belonging, being and becoming: The Early Years Learning Framework for Australia (EYLF V2.0):* 1. Identity, belonging, sense of self, family and culture; 2. Connectedness with others; 3A. Emotional wellbeing; 3B. Physical wellbeing; 4. Constructing knowledge and understandings; 5. Communication.

RESULTS. The ORICL prototype tool was evaluated with 21 educators in a diverse sample of centre- and home-based ECEC services across four Australian states (NSW, VIC, QLD, and WA) who used ORICL with 66 children aged 6 to 33 months. Psychometric analyses confirmed that the content of the ORICL tool was reliable and valid. Each of the domains met statistical criteria for internal reliability (alfa coefficients over 0.7). Domain scores were correlated with child age (higher ratings for older children) but showed no differences for boys and girls. Interviews with educators confirmed the method was appropriate and relevant. They stated that ORICL: supported them to observe and document children's learning; enabled a more holistic understanding of the children in their care; helped them to focus on and reflect critically on their own practices; promoted professional conversations with colleagues; and supported communication with families. One educator explained that the strength-based content was particularly helpful for difficult conversations with families regarding early intervention. Other educators commented that ORICL revealed "new things" and "raised questions" that they then discussed with families.

CONCLUSIONS. The feasibility and relevance of ORICL suggests its potential for triggering significant and sustained improvement in pedagogy and practice for infant-toddler education and care. Further research has been funded to (1) generate the evidence needed to assess the uptake and impact of ORICL, its usefulness as a professional learning resource, and its coherence and reliability as a measure of infant-toddler learning experiences; and (2) advanced knowledge of infant-toddler pedagogy and practice that will support evidence-based local and/or system-wide innovations and policies to improve the quality of ECEC for children under 3-years.

P1-B-30 - Using infant facial analysis to advance on-line preference testing methods - an exploratory study

Linda Polka [1], **Fernanda Alonso Arteche** [1], **Joseph V. Casillas** [2], **Cristina Galusca** [3], **Hiromichi Hagihara** [4], **Nanako Kimura** [5], **Louisa Kulke** [6], **Lorijn Zaadnoordijk** [7], **Sho Tsuji** [8]

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Details

Looking behavior is widely used to index infant preference in both visual and auditory tasks. Classic infant test paradigms (e.g., habituation) also require stimulus presentation contingent on looking. The ManyBabies-AtHome (MBAH) project is focused on establishing reliable protocols and tools to implement looking-based infant perceptual tasks in a remote on-line testing environment. As a first step toward this goal, a methodological study was conducted to evaluate the ability to reliably assess infant looks in a remote setting via a webcam. A visual preference task was designed and implemented on the Lookit platform; in this task, infants were presented visual stimuli on a computer screen while they are video recorded via the webcam. This initial MBAH study attempts to replicate two visual preference

findings reported in the literature; one related to stimulus movement and one related to stimulus complexity. Similar to Teller (1979) infants were presented fixed-duration trials (20 sec) with different visual stimuli on either the left or right of the screen; stimuli varied across the 12 test trials to assess preference for static vs dynamic patterns and for simple vs complex patterns. Stimuli are accompanied by the same background music on each trial for some infants; others see the stimuli with no background music. 50 infants between 3 and 12 months completed the task. Infant looking time to each trial was coded both manually and using automated gaze coding tools**.** Here, we build on this initial MBAH study by exploring the utility of implementing infant facial analysis to improve or augment remote testing protocols for measuring infant preference. To do so, we are analyzing the video-recordings collected in this MBAH pilot study using BabyFaceReader to gain measures of global affective valence, arousal, and strength of a happy facial expression. We will examine whether these infant facial attributes differ as a function of the three variables manipulated in the MBAH visual preference task: 1) task condition (with vs without background music); 2) stimulus movement (static vs dynamic), and 3) stimulus complexity (low vs high). This will be an exploratory study as there has been very little prior work using infant facial analysis. (Study preregistration is found at https://osf.io/4bwh9/?view_only=faffa921ad6a4186ab17872046d4fcf8) The findings will be informative in several ways. First, they may point to ways to optimize infant engagement and reduce subject attrition in the remote testing context. Second, they may suggest ways to integrate looking time and facial expression measures to gain a more potent and meaningful assessment of infant preference. Third, they can uncover the current limitations and challenges associated with using facial analysis with infants in a remote testing environment.

P1-B-31 - The optimum-1 as a new tool for developmentalist: a time efficient MMN paradigm

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Details

The mismatch negativity (MMN) is an event related potential (ERP) triggered when the brain's participants process a change in a sequence of stimuli. This tool has also been used by developmentalist to test infants' auditory perception (see Cheour et al, 2000 for a review). While MMN experiments present the advantage of testing infants' perception passively, ERP paradigms require to collect a big number of trials rendering those experiments potentially longer than behavioural experiments. Additionally, classical MMN paradigm are oddball, where standards represent 80% of the stimuli and deviants 20%, rendering the amount of exploitable data low. Consequently, those experiments have a high attrition rate (25–75% according to Hoehl & Wahl, 2012). The optimum-1 paradigm (Näätänen et al, 2004) can solve this issue at it allows to collect a big amount of data in few minutes.

In the optimum-1 paradigm, standards and deviants are presented in alternance allowing experimentalist to exploit the whole recording. Previous studies have used this paradigm in adults, children (Lovio et al,

2010) and in pre-school toddlers (Putkinen et al, 2012) no infants were tested with this paradigm to the best of our knowledge. Here, we aim to verified that this paradigm can be used with 9-month-old infants.

In our study, the optimum-1 has been designed as a secondary task. The goal is to use this fast way to collect many trials to use it as a *localizer* for our main task (see Fort et al., 2017). By identifying the MMR on a secondary task, we can increase the study's statistical power and make a potential null result more informative. This is exactly what we did in this project, the Babe with the predictive power (https://osf.io/8jcpy/) aiming to determine whether infants can predict the upcoming syllable of a word. This work has been accepted as a stage 1 pre-registered paper in Developmental science.

We are currently collecting data and have tested 16 9-month-old infants. The optimum-1 consisted of complex tonnes where the fundamentals frequencies mimic some English vowels (see figure 1). In 2 blocks of 2.3 minutes, we collected 362 trials (2x85 standards and 17 deviants of each kind), after data cleaning we can analyse an average of 183 trials (range 57:281, STD 66). We were able to run a cluster analysis on individual babies data, the result of this analysis is presented in figure 2. A secondary data analysis used a cluster permutation analysis on the group and found 2 effects a fronto-central positivity starting at 200ms until 400ms (t(15)= 2689; p=0.025) followed by a right-lateralized negativity starting 480ms to 560ms (t(15)= -2061; p=0.042).

Altogether those results showed that, optimum-1 can be used to study perception in infants and that the efficiency of this paradigm is ideal for developmentalists. Despite the relatively small sample of infants the data gathered to date, allowed us not only to run a group level data analysis but also individual cluster permutation analysis. This offers big potential for future experiments especially the one focusing on individual data analysis.

P1-B-32 - Maternal sensitivity in parent–infant interactions; A quantitative analysis of the effects of maternal sensitivity in parent–infant interactions

Serena Kongnukool [1], **Rebecca Pearson** [1]

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Details

Background: The quality of the parent-infant relationship is grounded within the constructs of sensitivity, which is critical for the child's early childhood development, including attachment, social-emotional development, cognition development, and clinical outcome (Ainsworth, 1978). In addition, the quality of the parent–infant interaction is crucial for the child's development in early childhood, including attachment (Benoit, 2004), social–emotional development (Kochanska et al. 2005), cognitive development (Fernandes et al., 2021) and clinical outcome (Sleed and Fonagy, 2012). However, despite the abundance of research regarding the importance of parental and infant interactions, there is a lack of consensus in the field regarding what exactly constitutes sensitive parenting. This raises the possibility

of evaluating whether the complexity of the maternal sensitivity construct has been adequately handled and directed researchers' attention to the area of methodology.

Aims: The objective of the current study was to analyse the range of emotional expression through facial expression and behavioural sequences through vocalisation in relation to visual attention observed between the parent and the infant. The current study aimed to discover whether child led or parent led visual attention patterns are associated with greater facial expression, vocalisation and positive affect for the child parent-child interactions.

Methods: The study used data from two populations of parent-infant interactions: mother-infant dyads from the Avon Longitudinal Study of Parents and Children (ALSPAC) and mother-infant dyads from the Soweto clinic in South Africa; mean infant ages 6 months. The study utilised synced parent-infant video dyads which were recorded as observational data and sequentially coded within via microanalysis. This study implemented a cross-sectional nonexperimental correlational design followed by a regression analysis with two independent predictor variables; proportion of the total duration the caregiver looks at the infant [(visual attention (caregiver looks at infant)], proportion of the total duration the infant looks at the caregiver [(visual attention (infant looks at the caregiver)]; and three dependent variables; proportion of total duration of facial expression, proportion of the total duration of vocalisation, and the proportion of total duration of positive affect; with the proportion of the total duration infant face is visible as a controlling variable.

Results: Correlational analyses found all variables to be significantly related to one another. The regression found caregiver led interactions significantly predicted higher positive affectivity in the infants.

Conclusions: The findings of this study contribute to the current literature by assessing maternal sensitivity using a micro-coding analytic technique on data collected in a naturalistic setting using first person headcams, which could be used to guide early interventions aimed towards improving infants' socioemotional and cognitive development.

P1-B-33 - Automatic attention detection as a way to peek at the meaningful world from the infant's perspective

Yisi Zhang [1], **Astrid Priscilla Martinez Cedillo** [2], **Quoc Vuong** [3], **Harry Mason** [4], **M. Carmen Garcia-De-Soria** [4], **William Smith** [4], **Marina Knight** [4], **Elena Geangu** [4]

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Details

Understanding infant behavior in natural environments is challenging, particularly in gauging their spontaneous exploration and shifting attention, which varies widely and unpredictably compared to controlled behaviors in laboratory settings. To determine which environmental factors are relevant to

the infants, we used wearable sensors (Geangu et al., 2023) to measure infants' autonomic nervous system function (e.g., heart rate - HR) and movement (e.g., accelerometry - Acc), from which we could predict periods of sustained attention. The waveform of HR change surrounding sustained attention periods is a well-validated indicator of attention in laboratory experiments (Weber et al., 1994; Colombo et al., 2001), but may need to be adapted for naturalistic environments. This study aims to establish an automated attention prediction algorithm using validated data collected in the laboratory, and extend its application to the data recorded in the 'wild'. Our infant and toddler dataset (N=76; 6- to 36-months-old) contains electrocardiogram (ECG) and Acc data recorded concurrently with visual fixations using a head-mounted eye-tracker. The data was recorded while infants were playing freely in an open lab area (e.g. interacting with caregivers or toys). The fixation data was temporally synchronized to the ECG and Acc data. Humans hand-labeled periods of sustained attention based on a combination of infants' HR changes and fixations on different objects and people present in the play area. To automatically detect sustained attention, we first adopted change-point detection on HR, then trained a machine-learning model based on the time-frequency analysis of HR fluctuation and the accelerometer signal, and finally merged segments separated by brief gaps (Figure 1). We demonstrated that our attention model could predict visual attention without the visual information from the eye-tracker as a predictor. The model was further validated by testing hypothesized relations between the individual variations of the predicted attention manifested in the natural environment with established measures of emotionality and regulation (i.e., Infant Behavior Questionnaire – Revised (IBQ-R)). We collected both naturalistic data and IBQ-R from a different sample of 6-month-old infants (N = 30) than the one used for training the model. Our preliminary results show that natural statistics of the predicted attention correlate with IBQ-R scores for negative emotionality and regulation factors. Taken together, these findings indicate that this method is useful for naturalistic research outside the laboratory, with minimal intervention from researchers, since participating families can independently employ the wearable sensors.

P1-B-34 - It takes two: Screen-mediated adult-infant interactions in a minimalist virtual space

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Details

Learning from videos is typically thought to produce less satisfying learning outcomes among children than learning from live persons (the "video deficit", Anderson & Pempek, 2005). This deficit can be at least partly explained by the lack of interactiveness in video exposure, as studies show that the video deficit can be largely mitigated when the video is made interactive (i.e., live video chat, e.g., Roseberry et al., 2014). In the existing studies, however, adding interactiveness to video exposure has often introduced accompanying social signals that could potentially enhance learning in other ways, such as providing emotional cues and calling children by their names. The exact effect of interactiveness itself on children's learning remains to be specified by carefully controlling for other social cues present in interactive video exposure.
In this study, we developed a gaze crossing experiment that measures bidirectional real-time

interactions between infants and adults by exposing them to the temporo-spatial patterns of social interaction disentangled from other elements. As illustrated in Figure 1, an infant and a naive adult experimenter are seated separately from each other, facing a screen respectively. They explore a veiled 2-D virtual space reciprocally in a search game setup. Their gaze on the screen functions as a searchlight that unveils the region they are looking at. Both can encounter three identically looking objects: an "other" object that represents the real-time gaze of their partner, a "shadow" object that is not interactive but has the same amount of spatio-temporal movement as the "other" object, and a "static" object that stays in the same place. The infants (n = 35; age range = 8 to 14 months, mean = 320 days) explored freely, and the adult experimenters were instructed to identify the "other" object and stay with it. The only cue that infants can use to identify the interactive partner is thus the contingency of movement. Our results (Figure 2) show that infants were able to do so in these abstract conditions, encountering the "other" object more frequently (vs. shadow: Est. = 5.29, t = 5.33, $p < .001$; vs. static: Est. = 11.39, t = 11.48, $p < .001$) and looking at it for longer durations (vs. shadow: Est. = .34, t = 13.31, $p < .001$; vs. static: Est. = .15, t = 6.07, $p < .001$) compared to the remaining objects. These findings more precisely show the effectiveness of interactiveness in capturing and maintaining the attention of infants. The gaze crossing experiment also shows its potential to examine infant-adult interactions under rigorous experiment control.

P1-B-35 - Title: "I always wondered if my baby is able to feel my love for them"- Development and pilot testing of video feedback to improve maternal self-efficacy

Alessandra Prioreschi [1], **Deborah James** [2], **Shane Norris** [1], **Rebecca Pearson** [2]

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Details

Introduction: The aim of this pilot study was to describe the development of, and qualitatively test the acceptability and feasibility of providing individualised video feedback on mother-infant interaction behaviors. We hypothesised that providing individual behavioural feedback to mothers in a socially vulnerable context, when later embedded in supportive intervention approaches, may improve maternal self-efficacy and ultimately promote infant development. Methods: Feedback was developed following expert consultation with working groups, and included video feedback of mother-infant interactions using first person observation head cameras. Eight mothers of infants aged 4-months from South Africa wore the devices for one week, following which individual feedback on mother-infant interactions was delivered using a strengths based approach in the context of supportive guidance. Feasibility and acceptability was tested by administering questionnaires, and conducting focus group discussions using a semi-structured interview guide. Results: Mothers included in this study were generally single, unemployed, and less than half had completed formal schooling. Most mothers had two or more children, and lived in informal housing. The feedback was found to be both feasible, and largely acceptable in this context and compliance was 100%. All mothers (100%) reportedly enjoyed receiving the feedback, felt that the feedback would help them as a mother, felt that the feedback related to their goals as a mother, and felt that the feedback would help them understand and bond with their infant better. Mothers discussed feeling more confident, and feeling that they had learnt skills from the feedback sessions. The strengths based approach helped some mothers to realise they were doing better than they had previously thought. Mothers also reported some barriers to using the cameras, and some mothers felt the

videos did not always capture their strengths correctly. Discussion: We have been able to develop feedback with the potential to sensitise mothers to their infants' behaviours. We have also learnt how to modify the feedback approach to better suit mother's needs. When embedded in a supportive intervention, these feedback modalities have the potential to improve mother's self-efficacy through increasing feelings of competence and reflexive functioning.

P1-B-36 - Computerized adaptive testing of early child development – evidence from GSED

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Details

Introduction: The Global Scales for Early Development (GSED) project developed two forms for quantifying early childhood development (ECD): the directly administered Long Form (LF) and the caregiver reported Short Form (SF). Developmentally and age appropriate items are ordered according to their difficulty based on a modified Rasch model, which returns a common unit of measurement, the Developmental (D)-score, from item responses. This study pioneers computer adaptive testing of ECD with the GSED forms relying on the underlying Rasch model. Unlike conventional testing with a fixed sequence of item administration, items administered adaptively are selected by computer algorithm using prior item responses until a predefined stopping criterion is satisfied. For example, a starting item is selected based on child's age and the algorithm calculates an initial D-score from the response. If the stopping criterion is not met, the algorithm selects the next item that would provide maximal information given all previous responses by the child, and the cycle continues until the criterion is met. In this presentation, we aim to compare the validity and feasibility of adaptive vs. conventional fixed forms testing. We hypothesize that adaptive testing will reduce test length and administration time, be preferred by users, and retain equivalent D-score precision and ECD domain representation compared to conventional fixed forms testing.

Methods: We conducted an initial simulation study using existing data to tune the adaptive testing algorithm. Then, we collected new field study data using both adaptive and fixed forms administration to the same child, randomizing the administration sequence and varying the difficulty of the adaptive test. Participants included 473 children from Bangladesh, 462 children from Pakistan, and 473 children from the United Republic of Tanzania, aged 0 to 36 months. We compared test length, D-score precision, item exposure, domain representation, agreement between fixed and adaptive tests, and the relationship between test leniency and exit interview responses using Bland-Altman plots, equivalence tests, and chi-square tests.

Results: Domain representation from the GSED instruments was well reflected in the adaptive test configuration. Depending on study condition, the average difference in measurement error between adaptive and fixed testing varied between 0.01 and 0.70 standard deviations. The smallest differences were observed when the adaptive algorithm employed a standard error of measurement (SEM) stopping criterion at a moderate test level (i.e. item selection based on a probability to pass items of 0.7). Easier tests (i.e. probability to pass items = 0.9) increased measurement error, leading to larger disparities.

Compared to fixed sequence testing, the adaptive algorithm reduced both test length and administration time by a factor of three.

Conclusion: Overall, we found comparable D-scores between adaptive and fixed forms administration. Additionally, the representation of developmental domains across administered items of the adaptive test aligns with the domain distribution observed in the fixed GSED forms. The adaptive test was found to be efficient, provided precise and accurate measurements, and was easy to administer. We conclude that the adaptive GSED is an effective and efficient method for measuring development in children aged 0 to 3 years.

P1-B-37 - Clinical feasibility pilot of the NIH Infant and Toddler Toolbox

Patricia Blasco [1], **Natasha Ludwig** [2], **Kara Boynewicz** [3], **Christy Isbell** [3], **Michelle Johnson** [3], **Cara Cimino** [1], **Natalia Rich-Wimmer** [1], **Rowena Ng** [2], **Rebecca Lieb** [2], **Laura Stolpe** [2], **Alyson Chroust** [3]

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Details

NIH Baby Toolbox (NBT) provides an overall assessment of social, behavioral, cognitive, language, and motor development in children 1 month to 4 years of age. The NBT represents a downward extension of the widely used NIH Toolbox designed for use in individuals 3 to 85 years. Northwestern University and its collaborators have created the NIH Baby Toolbox and are nearing completion of norming using a nationally representative sample of 1-48-month-olds.

The NIH Toolbox has been cited in 428 publications, with over 100 of those publications related to work with clinical populations. Given the utilization of the NIH Toolbox in clinical populations, it is important to understand the feasibility of the NIH NBT for use in clinical populations as well.

Accordingly, a pilot study involving a multisite collaboration across academic medical centers is being conducted to shed light on the clinical feasibility of the NIH NBT. Clinical populations sampled across the three sites include infants and toddlers with prenatal substance exposure (n=10-20), Kabuki Syndrome (n=10), Down Syndrome (n=10), or those born preterm (n=20-30). Target sample sizes for each clinical sample are listed in parentheses. Clinical feasibility of the NBT will be assessed in terms of the validity of administered assessments throughout 2024 and recommended modifications for clinical populations. Specifically, feasibility will be assessed in terms of a) the proportion of measures completed by each group (and conversely, the proportion of missing data); b) the proportion of measures requiring modification or adaptation, and c) the recommended modifications for each clinical population.

This study will help neurodevelopmental scientists and clinicians understand whether the NBT may be a viable research tool to capture developmental trends across diverse clinical populations. This is critical given that valid administration of extant standardized measures such as the Bayley Scales of Infant and Toddler Development, Fourth Edition or the Mullen Scales of Early Learning is often compromised when applying these tools to young children with severe cognitive and/or motor impairments. The NBT may tap overall strengths as well as concerns across a number of domains, including several areas not traditionally examined in a direct, norm-referenced, and standalone manner within this age range (e.g., executive functioning, numeracy, social observation). Thus, it may be a useful tool for clinicians working with young children who have or are at-risk for developmental delays. This battery, along with the existing NIH Toolbox, will allow for more sensitive monitoring of developmental trajectories within early childhood and across lifespan, which is a major gap in the literature. Documentation and sharing of potential accommodations and/or modifications generated by the clinical sites will provide important information for promoting accessibility in future versions of the NBT and other assessment developers looking to develop or refine measures with clinical populations.

P1-B-38 - Reliability and validity evidence for the use of the GSED in four countries: Bangladesh, Côte d'Ivoire, Pakistan, and Tanzania

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Details

Introduction: This research focuses on the validation of two versions of the Global Scales for Early Development (GSED) for assessing children aged 0–3 years globally: the 139-item caregiver-reported Short Form (SF) and the 155-item directly administered Long Form (LF). The objectives for the GSED included: i) aiding in the assessment of the UN Sustainable Development Goal (SDG) 4.2.1, which is centred on tracking the developmental progress of children, and ii) evaluating the effectiveness of programs and interventions. To achieve these objectives, the GSED were created using a common underlying scale, the Developmental (D)-score, to be: i) reliable and valid across diverse cultural, linguistic, and socioeconomic contexts, ii) predictive of future developmental outcomes, iii) culturally and contextually adaptable, iv) freely accessible, v) straightforward to administer and scalable, and vi) capable of providing age-adjusted benchmarks on a global scale. We hypothesise that an early childhood development (ECD) tool that functions similarly and permits comparisons across diverse global contexts is feasible.

Methods: This presentation reports on the validation of the GSED with 5775 children aged 0-42 months living in four disparate settings: rural Bangladesh, urban **Côte** d'Ivoire, peri-urban Pakistan, and remote Pemba Island, United Republic of Tanzania. D-scores for each child were estimated from GSED SF and LF item responses, as well as combined (C) responses from the two forms (GSED CF), using a modified Rasch model that links the tools to the underlying score. Performance of GSED CF, SF, and LF were assessed by: i) reliability, via an examination of intraclass correlation coefficients (test-retest and inter-

rater) and the pseudo reliability coefficient, ii) concurrent validity, via correlations with the Bayley Scales for Infant Development III (BSID-III), and ii) convergent validity, via correlations with factors known to associate with ECD, e.g., maternal education, socio-economic status, and childhood malnutrition.

Results: Figure 1 shows the distribution of the D-Scores with age, demonstrating similarity in age related ability and dispersion across all four countries. Inter- and Intra-rater reliability coefficients, and intraclass correlations (ICC2), were greater than 0.98 for all forms (GSED CF, GSED SF & GSED LF) in all countries. For concurrent validity, all forms correlate r>0.88 with all domains of the BSID III, and r>0.9 with the BSID III total score. For convergent validity, the age adjusted GSED-CF correlates statistically significantly in the hypothesised directions with almost all of the posited convergent measures. This was also true, in almost all cases, for the age-adjusted GSED SF and GSED LF against the convergent measures.

Conclusion: The GSED demonstrated excellent reliability and validity in a multi-country study across diverse cultural, linguistic, and socioeconomic contexts, establishing its utility as a global child development assessment tool.

P1-C-39 - The impact of maternal stress during pregnancy on pre- and postpartum bonding

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Details

INTRODUCTION

Prenatal life is a critical period with potential long-term effects on an individual's health. Maternal stress during pregnancy, a prevalent issue, has been linked to adverse outcomes in offspring. While existing research has explored its impact on physical and mental health, minimal attention has been given to its influence on mother-child bonding. This study aims to address this gap by investigating whether maternal stress during pregnancy negatively affects mother-child bonding, both pre- and postpartum.

METHODS

N = 316 pregnant women, who screened positively for emotional distress (EPDS > 9) were included in the study between the 12th and 28th gestational week, Digital assessments, utilizing the PHQ-D stress scale, the Maternal-Fetal Attachment Scale (MFAS), and the Postnatal Bonding Questionnaire (PBQ-16) were applied during the last trimester of pregnancy and one and five months postpartum.

RESULTS

Maternal stress during the 28th gestational week had a mean score of 6.77 (SD = 3.42; Min = 0; Max = 20). Prepartum bonding scores increased from 116.96 (28th week) to 125.96 (36th week). Postpartum bonding remained stable from one month to five months postpartum, with a higher maximum score at five months (Max = 77 vs. 55). Maternal stress negatively correlated with pre- and postpartum bonding one month

after birth (<.01). However, stress and postpartum bonding at five months were not significantly associated.

CONCLUSION

This study sheds light on the impact of maternal stress during pregnancy on mother-child bonding, addressing a significant gap in existing research. The findings reveal that maternal stress during pregnancy is associated with lower pre- and postpartum bonding one month after birth. The lack of a significant correlation between stress and postpartum bonding at five months suggests potential complexities in the long-term dynamics of this relationship. These results emphasize the importance of recognizing and addressing maternal stress during pregnancy for promoting positive mother-child bonding outcomes. Further research is warranted to explore the nuanced factors influencing the trajectory of maternal stress effects on bonding beyond the early postpartum period.

P1-C-40 - Transdiagnostic mapping of cognitive development and spectral power in infants at elevated likelihood of Autism and ADHD

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Details

Autism and ADHD are among two of the most common developmental conditions globally, yet understanding of the underlying neural mechanisms are limited. High levels of heterogeneity in symptoms and comorbidity across conditions has encouraged a transdiagnostic approach to studying these conditions. Siugzdaite, Bathelt, Holmes & Astle 2020, used machine learning to map the cognitive and structural brain profiles of children aged 5 to 18 years, showing that cognitive profiles did not align with diagnoses of ADHD, autism and dyslexia, and the relationship between each child's best-matching cognitive profile and brain profile were not one-to-one. This suggests the same brain profile could be associated with different cognitive difficulties and vice versa, supporting the idea of equifinality, which supposes that distinct neural pathways could lead to the same cognitive condition, as well as multifinality, which posits that the same neural difference could result in multiple cognitive profiles. These are important notions in the transdiagnostic framework, as it implies that diagnostic categories cannot capture the underlying truth about how developmental difficulties arise and evolve, thus impeding the development of interventions that can adequately support the needs of children with developmental conditions.

We will investigate the relationship between cognitive and spectral power profiles of infants aged 24 months. Scores from the Mullen Scales for Early Learning (MSEL) will be used to stratify subjects into subgroups, forming cognitive clusters. We also derive neural clusters from electroencephalography (EEG) power measures, which will be separated into 3 spectral frequency bands: alpha, theta and beta, across 8 groups of channel regions: frontal, parietal, occipital and temporal in left and right hemispheres respectively. The Vineland Adaptive Behaviours Scale II (VABS-II) will be used to validate the data-driven subgroups. We will examine the association between cognitive subgroups and neural subgroups to

probe the concept of multifinality and equifinality. We predict that there will be a small but significant association between cognitive and spectral power clusters, and that this relationship will not be one-to-one. This will be supported if individuals from one cognitive cluster map onto multiple neural clusters and vice versa. We will also investigate the association between the data-driven groups and clinical likelihood for Autism and ADHD, determined by familial liability, as well as diagnostic traits, including restricted repetitive behaviour, social skills and externalising behaviours. These traits have been measured using the Autism Diagnostic Observation Schedule-2 (ADOS-2), Autism Diagnostic Interview-Revised (ADI-R), Child Behaviour Checklist for Ages 2 to 3 (CBCL/2-3) and Conners Early Childhood (Conners EC). This will determine the extent to which data-driven groups are truly transdiagnostic, or if they reflect ADHD and/or autism familial influence or dimensional traits.

Figure 1 provides a diagrammatic representation of the planned analyses. The pre-registered analysis plan can be found at the following link: https://doi.org/10.17605/OSF.IO/6BVSJ .

P1-C-41 - Prenatal emotion dysregulation predicts infant social-emotional development

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Details

Prenatal maternal emotion dysregulation, a transdiagnostic measure of psychopathology, may increase the risk for socioemotional difficulties in early childhood. For example, higher levels of prenatal maternal emotion dysregulation have been associated with more newborn arousal and less attention at birth, and worse socioemotional functioning at 2-months (de Campora et al., 2014; Muzard et al., 2023; Ostlund et al., 2019). Socioemotional functioning during infancy is critical for healthy development and lays the foundation for important skills such as interpersonal functioning, emotion regulation, and academic success (Alzahrani et al., 2019). Despite the significance of these skills, there is limited research exploring how adaptive psychosocial factors, particularly maternal mindfulness, may interact with prenatal maternal emotion dysregulation to predict infant socioemotional functioning. This study explores the association between maternal emotion dysregulation during pregnancy—measured via self-report and autonomic nervous system measure of maternal resting respiratory sinus arrythmia (RSA)—and infant socioemotional functioning at 18-months. We also investigate whether this association was moderated by maternal mindfulness at 7-months postpartum.

Mother-infant dyads (*N* = 385; 52% female; 71% White; 74% non-Hispanic) participated in a longitudinal study from pregnancy to 18-months postpartum. During the prenatal visit, mothers completed the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) and maternal resting RSA was collected continuously via ECG for 10 minutes. At 7-months postpartum, mothers completed the Mindful Attention and Awareness Scale (Brown & Ryan, 2003). Lastly, when infants were 18-months, caregivers completed the Infant Toddler Social and Emotional Assessment, measuring externalizing and

internalizing behaviors, dysregulated behavior, and social-emotional competence (ITSEA; Carter et al., 2003).

Structural equation models were conducted to examine the associations between prenatal maternal emotion dysregulation, measured with the DERS and maternal resting RSA, and infant social-emotional development. Results indicated that higher scores on the DERS predicted higher scores on the externalizing behavior and dysregulation scales (β=0.29, p<.001 and β=0.16, p=.017, respectively). Additionally, maternal mindfulness at 7-months moderated the association between maternal resting RSA and these infant socioemotional outcomes (externalizing: β=-0.25, p=.019; dysregulation: β=-0.26, p=.015). Among mothers who reported high mindfulness, higher resting RSA was associated with fewer externalizing and dysregulation behaviors (β=-0.32, p=.002 and β=-0.51, p=.016, respectively).

Infants exposed to higher levels of prenatal emotion dysregulation, measured via self-report and resting RSA, may be at heightened risk for socioemotional difficulties at 18-months. Maternal mindfulness offers a potential avenue for intervention, as mothers who report high mindfulness and have higher resting RSA have infants with fewer socioemotional difficulties at 18-months. However, we did not find an interaction between self-reported maternal emotion dysregulation and mindfulness. This is likely due to shared method variance, which further points to the importance of considering the potential impact of biobehavioral measures of prenatal emotion regulation on infant socioemotional outcomes. Future research could explore the mechanisms through which maternal mindfulness buffers against prenatal maternal emotion dysregulation.

P1-C-42 - Examining the effect of sociodemographic factors on neonatal neurobehavior

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Details

Background: In preterm infants (<32 weeks gestation), sociodemographic factors, such as maternal education, have been shown to influence infant neurobehavior, where infants with higher risks displayed worse attention, self-regulation, hypertonia, and more stress signs (McGowan et al., 2020). Previous studies have been conducted within the infant's first three days of life, but have yet to examine the effects of sociodemographic factors on neurobehavior later in infancy, after the infant has adjusted to their home environment. There is a critical gap in our understanding of how sociodemographic risk factors, such as maternal education and race, may influence infant neurobehavior in healthy, full term infants.

Objectives: This study aims to identify how sociodemographic factors, including maternal education and race, influence infant neurobehavior in the first 8 weeks.

Methods: Participants included 24 infants (Male=10) in a longitudinal study on the development of social communication. The Neonatal Neurobehavioral Scale is a standardized assessment of infants' neurologic integrity, behavior function, signs of stress (Lester et al., 2004) and was administered on full term infants (M=38.07, sd=2.35) between 1 and 8 weeks (M=4.58, sd=1.86). Participants self-reported

race and education, and were dichotomized by demographic information. High Education (HE) included mothers with a college degree or higher while Low Education (LE) included mothers without a college degree.

Results: In regard to education, HE infants showed higher levels of attention, ($t(29.03)=-20.23$, $p<0.001$) and regulation ($t(43.97)=-31.21$, $p<0.001$) while LE infants showed higher levels of arousal ($t(43.16)=-20.49$, $p<0.001$) and excitability ($t(25.35)=-5.9$, $p<0.001$). See Figure 1.

In regard to race, nonwhite infants showed higher levels of attention ($t(29.03)=-19.38$, $p< 0.001$), regulation ($t(43.97)=-29.66$, $p< 0.001$), and excitability ($t(25.35)=-5.37$, $p<0.001$), while white infants showed higher levels of arousal($t(43.16)=-18.98$, $p< 0.001$). See Figure 2.

No differences were noted between groups in levels of hypertonicity or hypotonicity.

Discussion: Our findings demonstrate that infants show differing abilities in attention, regulation, arousal, and excitability based on race and maternal education, but hypertonicity and hypotonicity is not impacted by either sociodemographic factor. This reveals that neuromuscular behaviors are not impacted by the explored sociodemographic factors, while other neurological factors are. Further research is necessary to determine the impact of maternal education mediated by race, and how these differences in neurobehavior impact the development of later cognitive skills. By July 2024, we expect to enroll 30 more unique participants.

P1-C-44 - Links between infant surgency, toddler impulsivity, and toddler ADHD symptoms

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Details

Surgency is a temperamental trait that is characterized by high sociability and higher comfort approaching unfamiliar situations (Rubin et al., 1995). While these can be positive attributes, children who exhibit high surgency may be at risk of developing externalizing behaviors (e.g., impulsivity; Stifter et al., 2008). The extant literature is limited regarding the possible links between infant surgency and later externalizing problems, like ADHD symptoms in toddlerhood (Frick et al., 2018). In one of the few studies to consider such a question infant surgency/affectivity was directly related to later hyperactivity/impulsivity in 3-year-olds (Frick et al., 2018); however, in a cross-sectional study, infant surgency was not a significant mediator between executive function and ADHD symptoms in children aged 4-7-years old (Kostyrka-Allchorne et al., 2023). Several longitudinal studies also failed to show that surgency was related to ADHD symptoms in children ages 6 to 14 and 3 to 6, respectively (De Pauw & Mervielde, 2011; Martel et al., 2014). The limited evidence to date suggests surgency may be a more salient risk factor for ADHD symptoms earlier in life, but then fades as a risk indicator as children grow older. Additionally, existing studies have largely focused on preschool-aged and older children, leaving a gap in addressing links between infant surgency and ADHD symptoms in toddlerhood. The current study addresses these gaps by examining the associations between infant surgency at 12 months of age and

impulsivity and ADHD symptoms at 18 and 24 months of age, respectively. Furthermore, we test if impulsivity mediates the association between early surgency and ADHD symptoms.

The sample consisted of 179 mother-infant dyads. Of this sample, 47% of infants were male, 59.22% reported being economically stressed. Mothers were 71% Caucasian, 16% African American, 9% Hispanic, 1% Native American, 3% Other. Mothers completed measures of infant surgency when infants were 12 months of age (i.e., Infant Behavior Questionnaire-Revised; Garstein & Rothbart, 2003), toddler impulsivity at 18 months (i.e., Early Childhood Behavior Questionnaire; Putnam et al., 2006), and ADHD symptoms at 24 months (i.e., Child Behavior Checklist; Achenbach, 2000). Novel behavioral markers of impulsivity – derived from approach behaviors during a Stranger task – also were obtained during a laboratory visit when children were 18 months of age. The SEM employed to test hypotheses exhibited good fit, (X^2 (20) = 14.30, p = .82; CFI = 1.00; RMSEA = 0.00; SRMR = .029). Infant surgency/impulsivity at 12 months significantly predicted impulsivity at 18 months of age (β = .53, p < .01), and increased impulsivity at 18 months significantly predicted ADHD symptoms at 24 months of age (β = .59, p < .01). Interestingly, the direct association between infant surgency and ADHD symptoms was negative (β = -.35, p < .01). However, as expected, impulsivity at 18 months of age mediated the relationship between infant surgency/impulsivity at 12 months and ADHD symptoms at 24 months of age (Indirect effect; β = .31, p < .01) in the expected direction.

The implications of these findings for future research will be discussed.

P1-C-45 - Autism spectrum disorder and co-occurring medical conditions in infancy

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Details

Autism Spectrum Disorder (ASD) is an early onset neurodevelopmental disorder characterized by social communication deficits and restricted interests and repetitive behaviors. The relationship between ASD and an array of co-occurring physical and mental conditions has been the focus of extensive scientific research, pointing to a complex and poorly understood web of interactions between genetic, environmental, and other factors. Numerous studies have sought to understand the etiologies of medical conditions in individuals with ASD, however few studies have looked at the prevalence of such conditions in the earliest stages of life or the relationship with autism outcomes.
The goal of this study is to determine whether co-occurring medical conditions have elevated prevalence in ASD individuals traced back to infancy, and to test the hypothesis that increased severity of ASD symptomatology correlates with increased prevalence of comorbidities.
A cohort of 350 infant siblings with typical and elevated likelihood for autism was followed longitudinally from birth to 36 months as part of an NIH-funded Autism Center of Excellence (NIH P50 MH100029). Clinical outcomes were assessed at 2 years of age using the Autism Diagnostic Observation Scale, 2nd Edition (ADOS) and Mullen Scales of Early Learning (MSEL) to determine indices of symptom severity and developmental abilities, with confirmatory diagnosis at 3 years. Parents of all infants were asked to complete comprehensive medical history forms, including information on medical conditions other than

autism.
In this cohort, 43 infants with an ASD diagnosis and 83 typically developing controls were identified. In 16 of the 19 categories of medical condition included in the medical history forms, ASD infants were more likely to present with a condition than controls, with similar order of prevalence to typical development (Figure 1). To investigate whether prevalence of co-occurring medical conditions was related to severity of ASD symptomatology at outcome, ADOS and MSEL subdomain scores were compared between ASD and control subgroups with and without each condition, using permutation tests to test for significant differences. Although expected differences in scores were found between autism and typical development, our results showed no significant association within diagnostic groups between severity scores and relative prevalence in any condition (P>.05). We had predicted differences related to expected associations between ear abnormality and receptive language (Figure 2) or orthopedic abnormality and fine motor skills, for example, but no such differences were apparent.
The results of this study indicate that, although there is a higher prevalence of co-occurring medical conditions in infants diagnosed with ASD relative to typically developing controls, this does not appear to be related to symptoms of autism. Limitations of the study include the relatively small sample size and the lack of detailed objective measures quantifying the severity of each medical condition, indicating the need for further research.

P1-C-46 - Temperamental precursors to anxiety in children with elevated- and low-likelihood for autism spectrum disorder

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Details

Introduction: Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social communication difficulties and restricted and repetitive behaviors. In ASD, anxiety is highly prevalent, affecting up to 62% of individuals (Vasa et al., 2020). Behavioral inhibition (BI), a component of temperament characterized by wariness towards novel stimuli (Fox et al., 2001), has predicted anxiety symptoms in infancy and childhood (Buss, 2011). However, little is known about how the components of BI, shyness and fear, differentially predict anxiety symptoms and how these relationships vary in children diagnosed with ASD and children at elevated likelihood for ASD (i.e., have older sibling with ASD; EL-ASIBs) contrasted to low-likelihood children (LL). This study examines the development of shyness and fear and their relationship with later anxiety symptoms across three groups of children: ASD, EL-ASIBs, LL.

Methods: Participants included 143 children (ASD: n=54; EL-ASIB: n=42; LL: n=47). Temperament was collected longitudinally between 16 and 65 months of age. Shyness and fear were measured from the Childhood Behavior Questionnaire (Putnam et al., 2006; Rothbart et al., 2001). Anxiety symptoms were assessed at the final timepoint using social anxiety and separation anxiety scale raw scores from the Preschool Anxiety Scale (Spence et al., 2001). Developmental changes in shyness and fear were analyzed using multilevel models. Random intercepts and fixed effects of age, group, and age-by-group interaction were included. Individual intercept values were extracted for each participant. Four separate

multiple regression models were conducted to examine how shyness and fear at 30 months (grand mean age) predicted social anxiety and separation anxiety symptoms at 60 months.

Results: A group effect was detected with higher shyness in the ASD group than the LL group at 30 months (*b*=0.46, *p*=.048; Figure 1). No other group differences (*p*s>.123) or age effects were indicated (*p*=.987). Fear increased over time (*p*<.001; Figure 2) but no group differences were detected (*p*s>.526). Shyness at 30 months predicted social anxiety symptoms (*b*=1.89, *p*=.004) and separation anxiety symptoms at 60 months (*b*=0.998, *p*=.048). A group effect was detected with shyness predicting social anxiety in the EL-ASIB group relative to the LL group (*b*=2.52, *p*=.020). There were no other group differences (*p*s>.549). Fear at 30 months predicted separation anxiety symptoms at 60 months (*b*=2.15, *p*=.048) but not social anxiety symptoms (*p*=.232). There were no group effects.

Conclusion: Findings suggest that fear and shyness have distinct roles in predicting separation and social anxiety symptoms in children with elevated and low likelihood for ASD. Shyness, which is relatively stable in early childhood and is elevated in children with ASD, is related to later social and separation anxiety. Meanwhile, fear increases in early childhood, does not significantly differ between groups, and is related to separation anxiety, not social anxiety. Due to the critical nature of early detection and intervention, it is crucial to consider individual differences in temperament. Understanding the role of early fear and shyness in the developmental paths of separation and social anxiety is essential for pinpointing timing and targets for interventions tailored to children with diverse temperaments.

P1-C-47 - Examining the impact of a prenatal SARS-CoV-2 infection on infant developmental outcomes through the first 24 months of life

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Details

Background: More than 58 million pregnant individuals experienced a SARS-CoV-2 infection during the COVID-19 pandemic. Respiratory viral infections during pregnancy are associated with poorer neurodevelopmental outcomes and an increased risk for developmental delays in children. Whether a prenatal SARS-CoV-2 infection has a similar impact as other viral infections remains unclear. Most research to date has examined the impact of a prenatal SARS-CoV-2 infection on infants' developmental milestones at one time point between birth and 18 months of age and has not included a negative control group. In this work, a prenatal infection had an adverse effect on infants' fine motor skills. The present study examined whether infants exposed to a prenatal SARS-CoV-2 infection differed from negative controls on multiple neurodevelopmental outcomes, including sleep, temperament, developmental and socioemotional milestones, between 3 and 24 months of age.

Methods: Participants (N = 790) were drawn from a prospective pregnancy cohort study of the impact of the COVID-19 pandemic on pregnant individuals (enrolled between April 2020 and April 2021). Individuals who indicated they had a likely SARS-CoV-2 infection were invited to participate in the

present study. Participants were asked to provide (1) documentation of a positive SARS-CoV-2 PCR test during pregnancy performed by a health authority, and (2) a dried blood spot sample to be tested for SARS-CoV-2 antibodies. Participants were categorized as having a *prenatal SARS-CoV-2 infection* (*n* = 68) if they provided a positive PCR test taken during pregnancy, or (2) *negative controls* if they did not experience any symptoms consistent with SARS-CoV-2 and did not have any SARS-CoV-2 antibodies in their dried blood spot samples (*n* = 722).

At infant ages 3 and 12 months, caregivers completed the *Brief Infant Sleep Questionnaire* (BISQ) as a measure of sleep. At 6 and 24 months, respectively, caregivers completed the *Infant Behavior Questionnaire* (IBQ) and *Early Childhood Behavior Questionnaire* (ECBQ) to assess infant temperament. At 12 and 24 months, caregivers reported on their infants' developmental milestones using the *Ages and Stages Questionnaire Third Edition* (ASQ-3) and socioemotional milestones using the *ASQ:Social-Emotional, Second Edition* (ASQ:SE). Information on participants ethnicity; socioeconomic status (education, income, and food insecurity); delivery method; and infant's sex, gestational age, and birth weight were collected at study enrollment and delivery and included as covariates in all analyses.

Analyses were run using ANCOVAs with robust standard errors and including all covariates. This study had 95% power to detect an effect size of Cohen's d ≤ 0.27, equivalent to a small effect size.

Results (see Table 1): Children with a prenatal SARS-CoV-2 infection had higher regulation scores on the Infant Behavior Questionnaire at 6 months, indicated better self-regulatory capacity, than children who did not have a prenatal infection. A prenatal SARS-CoV-2 infection was not significantly associated with any other neurodevelopmental outcomes.

Conclusion: Results suggest that prenatal SARS-CoV-2 infection has a negligible impact on a range of infant neurodevelopmental outcomes between 3 and 24 months of age. Additional longitudinal research is needed to determine whether these null effects persist at later developmental stages.

P1-C-48 - Developmental effects of congenital heart defects in infants with Down Syndrome

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Details

Down syndrome (DS), the most common genetic cause of intellectual disability[1], is characterized by high rates of co-occurring medical conditions, which increase the risk of poor developmental outcomes. Roughly 41 – 56% of newborns with DS have a congenital heart defect (CHD), which has a well-established negative impact on cognitive and language development in neurotypical children. Findings on the developmental impact of CHD in infants with DS are limited and mixed, with some evidence of lower cognitive, gross motor, and expressive language outcomes in infants with DS+CHD compared to those without[2], and other evidence showing no effect on developmental outcomes as a function of CHD in children with DS[3]. The present study investigated potential developmental differences as a function of CHD at 12- and 24-months of age in infants with DS. We also evaluated the potential effect of CHD on developmental gains from 12 – 24-months, which has yet to be studied. Finally, we examined potential

associations between the dosage of treatment types, including speech, occupational, and physical therapy, universally available to infants with DS, and development in infants with DS+CHD and DS-only.

Participants included 21 infants with DS+CHD and 16 infants with DS-only. The Mullen Scales of Early Learning (MSEL)[4] measured early cognition (Visual Reception), fine and gross motor, and receptive and expressive language at 12- and 24-months. We examined group differences via effect size estimates and evaluated differential patterns of association between development and therapy dosage across groups.

Mean difference effect size estimates[5] revealed differences of medium effect in cognitive ability, and Expressive Language at 12-months, as well as Receptive Language at 24-months (*d* range = 0.57 – 0.72). Group comparisons also revealed moderate differences in Receptive Language gains from 12 – 24-months (*d*= 0.60). Despite small differences in therapy dosage between groups, differential patterns of correlation were identified. For infants with DS+CHD, speech therapy dosage was significantly associated with Fine Motor gains from 12 –24-months (*p*=.042), and occupational therapy dosage was significantly associated with cognitive gains from 12—24-months (*p*=.016). Infants with DS-only showed significant associations between speech and expressive language at 12-months, speech and gross motor at 24-months, and speech and physical therapy and gross motor gains from 12-24-months (all *p-values*<.05); however, these were in the negative direction.

Findings highlight moderate developmental differences in some areas in infants with DS as a function of CHD. Interestingly, infants with DS+CHD showed moderately higher developmental abilities in cognition and language, and a faster rate of change in receptive language than infants with DS-only. This effect was not explained by differential doses of speech, occupational, or physical therapy between groups. While certain therapies were associated with some aspects of development in infants with DS+CHD, similar effects in infants with DS-only were not identified. Findings provide preliminary support for associations between motor and language in DS[6] and suggest that infants with DS may benefit from improved therapeutic approaches in early development.

P1-C-49 - Being born preterm or through emergency caesarean section: Impact on infants' self-regulation and on maternal sensitivity

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Details

Background. The context of the birth can be a source of stress for both the mother and the infant. Preterm birth (< 32 weeks gestational age) and Emergency Caesarean Sections (ECS) are highly stressful

births, as they both imply a threat for the baby's and/or the mother's life. These types of births can influence maternal care and mother-infant relationships. The quality of the mother-infant interaction, including maternal sensitivity, could therefore be compromised by the context of the birth. Furthermore, the infants' development of self-regulation may be affected. Indeed, studies have shown that preterm infants demonstrate less optimal self-regulation, and that being born through ECS is one factor associated with higher levels of behavioral problems. Both types of these highly stressful births may therefore share similar consequences on both the infants' and the mothers' behaviors but, to date, no study has compared these contexts of birth and their consequences. The aim of the present study is to investigate the effect of the context of birth on infant's self-regulation and maternal sensitivity in three groups of mother-infant dyads: a group of preterm births, a group of term ECS, and a group of term vaginal births (control group).

Method. 132 mothers and their 6 months-old infants (44 preterm birth, 44 term ECS, 44 term vaginal deliveries) were asked to interact during a 15-minutes free-play session. The mother-infant interactions were video-recorded. Maternal sensitivity and infant self-regulation were coded using the Global Rating Scale. Maternal depression was assessed using the Edinburgh Postnatal Depression Scale.

Results. When compared to the control group, in both the preterm and the ECS groups, lower maternal sensitivity and infants' self-regulation were observed. However, there was no difference between preterm and the ECS groups. A general linear model, including maternal (age, depression) and infant (gender) confounders as covariates, showed that, when compared to the control group, preterm birth was not predictive of lower maternal sensitivity (b= -.371, p = 0.67) but ECS was (b = -.579, p<.01). Furthermore, both preterm birth and ECS were predictive of lower infants' self-regulation (b = -.867, p <.001 and b = -.897, p <.001, respectively) when compared to the control group.

Discussion. The present study underlines the influence of highly stressful births on maternal sensitivity and infants' self-regulation. The fact that the results showed no differences in infants' self-regulation between preterm birth and ECS suggests that, even if the context is different, the consequences on the infant seem to be similar. As infants' self-regulation develops mainly through the interaction with the parents, further analyses will investigate the potential mediating role of maternal sensitivity in the association between the type of birth and infants' self-regulation. Moreover, one of the common aspects of both these births could be the maternal perception of a threat for the baby's life and future studies should investigate the role this perception plays in explaining the results.

P1-C-50 - Effects of preconception stress and prenatal vitamin D on infant temperament among Black caregiver-infant dyads

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Details

BACKGROUND AND OBJECTIVES. Black women living in Pittsburgh have some of the highest rates of prenatal morbidity in the U.S. in large part due to chronic experiences of racial inequality (Pittsburgh Gender Equity Commission, 2019). Although the association between prenatal stress and

neurodevelopmental problems in offspring is well recognized (e.g., Glover et al., 2018), several critical gaps remain. For example, there is limited understanding of 1) transgenerational effects of maternal stress experienced *prior* to pregnancy; and 2) prenatal buffers of preconception stress that could help explain variability in infant health outcomes. Vitamin D is an essential prenatal micronutrient and neuroactive steroid that is also involved in fetal brain development. Although prenatal vitamin D insufficiency (< 20 ng/mL) is common worldwide, there are known racial differences in cutaneous synthesis and their implications for health (Burris et al., 2015). We hypothesized that prenatal vitamin D would buffer the negative effects of preconception stress on infant temperamental features among Black mother-infant dyads.

METHODS. Study participants included 169 women (aged 22-30 years) enrolled in the longitudinal Pittsburgh Girls Study (PGS) who identified as Black (95.3%) or multiracial (4.7%). Participants reported on current life stressors in the period prior to pregnancy and completed a venous blood draw for measurement of circulating vitamin D [25(OH)D] during pregnancy. Participants reported on their infant's temperament (effortful control, negative emotionality) at age 6 months. Separate hierarchical regression models were used to examine the independent and interactive effects of preconception stress and prenatal vitamin D adjusting for parity, gestational weeks at prenatal blood draw, maternal age at birth, offspring sex and gestational age at birth, on infant temperament.

RESULTS. On average, participants reported three or more life stressors (range = 1-10) at the preconception visit and for 62% of the sample, prenatal 25(OH)D was below recommended levels. Results from hierarchical linear regression models revealed an independent risk of preconception stress on infant negative emotionality (β = 0.16, p<.05). In addition, results showed an independent promotive effect of prenatal 25(OH)D on infant effortful control (β = 0.17, p<.05), a result that remained after prenatal stress was also covaried. The interaction between preconception stress and prenatal 25(OH)D on infant temperament was not significant.

CONCLUSIONS. Results suggested different mechanistic pathways from preconception stress and prenatal vitamin D to infant temperamental outcomes at 6-months in the current sample of Black mother-infant pairs: maternal stress exposure showed specific associations with infant negative emotionality, whereas prenatal 25(OH)D concentration was associated positively with infant effortful control. No protective effect of maternal vitamin D in the context of stress was observed. With an increasing sample size, further analyses will examine differences by stress type and will probe interactive effects at varying levels of preconception risk and prenatal resilience. Clarifying these associations could inform the optimal timing of preventive interventions to promote child health and reduce health disparities.

P1-C-51 - Longitudinal trajectories of parental stress from infancy to childhood in fragile X syndrome with and without co-occurring autism spectrum disorder

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Details

Background: Parental stress during infancy is linked to a host of maladaptive child outcomes, including elevated mental health challenges[1] and disruptive behaviors during preschool[2]. The presence of neurodevelopmental disorders elevates risk for parental stress[3–5]. Autism spectrum disorder (ASD) and fragile X syndrome (FXS) are highly co-occurring neurodevelopmental disorders, with nearly 70% of individuals with FXS meeting criteria for ASD[6,7]. There is considerable phenotypic variation in FXS[8,9], with ASD co-occurrence associated with increased impairment[10,11]. The phenotypic variability[12] in FXS may lead to elevated parental stress in mothers, with up to 85% reporting clinically meaningful stress[13–17]. Mothers of children with FXS *or* ASD have increased stress relative to mothers of neurotypical children[18,19] and other conditions[18–20]. However, there is a tremendous gap in research on mothers of children with FXS *and* ASD (FXS+ASD) across infancy. Advancing knowledge on maternal stress trajectories in FXS and FXS+ASD will inform targets and timing of interventions, which is imperative to promote optimal outcomes.

Objective: Characterize longitudinal trajectories of parental stress in mothers of children with FXS and FXS+ASD beginning in infancy.

Methods: Fifty-four mothers of children with FXS indicated their parenting stress using the total score on the Parent Stress Index (PSI)[21] at 8 timepoints: 9, 12, 24, 36, 48, 60, 72, and/or 84 months. Higher scores indicated more stress. ASD was diagnosed at ~60 months to distinguish FXS infants with and without ASD ($n_{FXS+ASD}$ = 31, n_{FXS} = 23) using the clinical best estimate procedure[6,22–25]. A multilevel model[26–28] with fixed effects for age, group, and a group-by-age interaction and a random intercept assessed how co-occurring ASD impacted parenting stress trajectories; given FXS sex-differences[29,30], sex was controlled.

Results: The interaction between group and age was significant,  = 4.47, $t(141.00) = 4.02$, $p < 0.001$. Mothers of children with FXS+ASD experienced more change in stress per year relative to those with FXS. Yearly, mothers of children with FXS experienced a 0.07 point increase on the PSI, whereas mothers of children with FXS+ASD experienced a 4.54 point increase. This difference was most noticeable from 12 to 24 months. Mothers of children with FXS maintained stress levels in the 55th percentile (both sexes) from 12 to 24 months, whereas mothers of children with FXS+ASD experienced an increase from the 65th (female) or 70th (male) to the 75th percentile (both sexes) from 12 to 24 months.

Conclusions: Emerging between 12-24 months and persisting through 84 months, mothers of children with FXS+ASD experienced elevated parental stress relative to mothers of children with FXS. Differentiating stress levels may be due to increases in perceived challenging child behaviors in FXS+ASD. Increasing parental stress levels suggest that interventions minimizing parental stress should be applied during infancy for mothers of children with FXS+ASD to maximize the critical developmental trajectories beginning in infancy. However, since ASD is not diagnosed until 7 years-of-age in FXS[31], parenting stress

Back to top

interventions should be aimed towards *all* FXS families to target key intervention windows for children and to minimize the deleterious effects of long-term elevated stress[32].

P1-C-52 - Restrictive and repetitive behaviours in children with autism spectrum disorder and typically developing children in early childhood

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Details

Restrictive and repetitive behaviours (RRBs) represent a broad and often diverse group of behaviours that include motor stereotypies, compulsive and ritualistic behaviours, restricted and intense interests or activities, and repetitive self-injury. They are primarily associated with autism spectrum disorder (ASD) and are a criterion for the diagnosis of ASD alongside deficits in the social domain (DSM-V, 2013). While previous research focused primarily on the area of social communication, over the past decade the importance of RRBs in identifying autism and implementing interventions has been increasingly recognised.
RRBs are not unique to autism, but can also manifest in other developmental delays as well as typical development in the early and preschool years. While research indicates that these behaviours are more common and severe in autistic children compared to typically developing children, there is limited research on these behaviours in early-life autism, particularly in the first three years of life. The longitudinal course of the occurrence of typical RRBs is not entirely clear, so it is often difficult to distinguish typical from pathological RRBs, which poses a challenge for the early diagnosis of ASD. Many parents express concerns about their child's development before the age of two, but in practice there is still a considerable time lag between parental concerns, initial assessments and diagnosis. This delay reflects the complexity of the diagnostic process, the inadequate availability of diagnostic services and the reduced detectability of autism traits in early childhood.
Therefore, the aim of this study is to investigate the occurrence and differences in the frequency and intensity of RRBs in children with autism spectrum disorder (ASD) and typically developing (TD) children. It also aims to identify the items of the RRBs scale that are most discriminatory in recognising ASD children at an early age. The participants in this study are TD (N=35) and ASD children (N=20) with a mean age of 2 years who are matched in their nonverbal cognitive development. RRBs will be assessed with the Repetitive Behaviour Scale – Revised (RBS-R) (Bodfish et al., 2000), a parent-completed questionnaire. We hypothesise that RRBs will occur in both groups, with higher frequency and intensity in ASD children. In addition, certain behaviours that are typical of children with ASD and infrequent in TD children are identified as possible distinguishing characteristics between the two groups. This research contributes to clearer data on RRBs in early childhood and highlights the need for standardised diagnostic instruments and further research in early screening of ASD children.

P1-C-53 - A healthy start: Examining the contribution of caregiving quality to child physical health from birth to 14 years

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Details

The attachment theory emphasizes the role of caregiver sensitive responsiveness in shaping children's healthy development. However, it remains unclear whether variations in early caregiving quality in low-risk populations also influence children's physical health across development. In this study, we examined the impact of early caregiving quality, specifically maternal sensitivity, and infant-mother attachment security, on children's physical health from 0-14 years of age. We employed Bayesian generalized linear mixed models with Poisson distributions to analyze data from a low-risk Dutch sample from birth to age 14 (N=193). Analyses were performed statistically controlling for breastfeeding duration, centre-based childcare attendance, number of siblings, maternal education, and child sex. Maternal sensitivity was assessed five times from infancy (5 weeks) to adolescence (14 years), and attachment security at 12 months using the Strange Situation Paradigm. Child health complaints were recorded monthly in the first year and annually until 14 years of age and categorized according to the International Classification of Primary Care (respiratory, skin, general, and digestive symptoms; Figure 1).

We found that more sensitive mothers *in the first year of their infant's life* were more likely to report fewer health symptoms for the children in total (β=-0.043, 95% CI=[-0.769; 0.008], p=0.949), compared to less sensitive mothers. The analysis of the separate symptoms revealed that this effect was mainly due to lower respiratory symptoms (β=-0.068, 95% CI=[-0.203; -0.009], p=0.981). While other symptoms also decreased on average with increasing maternal sensitivity in the first year, we could not reject the null hypothesis for general, skin and digestive symptoms. Similar results emerged for the *average scores of maternal sensitivity throughout childhood*, with fewer total counts of health (β=-0.095, 95% CI=[-0.440; -0.022], p=0.988), respiratory (β=-0.110, 95% CI=[-0.348; -0.040], p=0.994), and additionally digestive symptoms (β=-0.142, 95% CI=[-0.475; -0.015], p=0.955).

Furthermore, mothers of insecurely attached children reported fewer symptoms for respiratory (β=-0.184, 95% CI=[-1.016; -0.049], p=0.990) and general (β=-0.189, 95% CI=[-0.469; -0.062], p=0.992) symptoms. Interestingly, an interaction emerged between EARLY maternal sensitivity and attachment security on children's physical health, wherein higher sensitivity was associated with fewer health symptoms, only in securely attached children (β=0.132, 95% CI=[0.009; 0.470], p=0.970; Figure 2). Instead, greater maternal sensitivity throughout childhood was linked to fewer health complaints in both securely and insecurely attached groups. This suggests that while sensitivity in the first year of life plays a different role for secure and insecurely attached children, long-term sensitivity is related to physical health beyond attachment security.

Drawing from a neuroendocrine perspective, these results align with the idea that higher maternal sensitivity enhances children's stress regulation, bolstering the immune system and reducing susceptibility to illness. Higher sensitivity may help mothers detect and address initial symptoms promptly, preventing these from progressing into more serious health issues. These findings contribute to the understanding of

normative variations in parenting practices and their role in child health within low-risk settings and advocate for considering a holistic approach to pediatric healthcare, emphasizing primary prevention, and recognizing the vital role of parental factors in safeguarding children's health and well-being.

P1-D-55 - Polarity of brain signals is linked to emergence of phonotactic repair in French-learning infants

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Details

Infants exhibit sensitivity to phonotactic probabilities and restrictions starting by 9 months, thereby demonstrating an attunement to language-specific input. Less is known regarding perceptual repair, a process in which illegal sequences are perceived as legal ones. One earlier behavioral study demonstrated a vowel-based phonotactic repair (*/abna/ → /abuna/) in Japanese-learning 14-month-olds, but not yet in 8-month-olds (Mazuka et al., 2011). The present study investigated the development of a consonant-based phonotactic repair mechanism (*/tl/ → /kl/ repair) in French-learning infants using the event-related potential (ERP) technique. We collected ERP data in three age groups of infants (at 7, 11, and 14 months) for three types of trials: same (/tla/-/tla/), different (/pla/-/tla/), and repair (/kla/-/tla/), organized into precursor-target trials (see Dehaene-Lambertz et al., 2000). Three tokens of either /tla/, /kla/, or /pla/ were followed by the target /tla/. The repair effect was determined by (1) no distinction between repair and same trials, and (2) differences in ERP amplitudes between repair and different trials. We hypothesized that if infants were sensitive only to acoustic changes, as predicted by language-general perception, responses to the same trials should differ from both different and repair trials (same ≠ (repair ≈ different)). In contrast, if infants showed language-specific repair, responses to different trials should differ from both same and repair trials ((same ≈ repair) ≠ different). Moreover, based on previous studies that showed polarity effects in infancy through familiarization-recognition paradigms (e.g., Kooijman et al., 2013; Von Holzen et al., 2018), infants were divided into two sub-groups (negative and positive responders) based on the polarity of the ERP amplitude difference between same and different trials. We hypothesized that negative responders (that is, infants with more negative ERP amplitudes in response to same than different trials) would show a stronger repair effect, or an effect earlier in age, than positive responders (e.g., Rivera-Gaxiola et al., 2005; Kooijman et al., 2013; Junge & Cutler, 2014; von Holzen et al., 2018). Our results revealed that the differential amplitude polarity interacted with the response both in the early ($F(4, 232) = 15.51$, $p = .001$) and middle ($F(4,232) = 5.91$, $p = .002$) time window. Infants with a negative polarity exhibited a repair effect, over frontal and parietal areas in both early and middle time windows. In contrast, positive responders demonstrated evidence for language-general perception. Age further interacted with response polarity both in the early ($F(2, 58) = 4.23$, $p = .019$) and middle ($F(2, 58) = 4.04$, $p = .023$) time windows. Negative responders displayed a repair effect across all ages, while a repair effect seemed to emerge in positive responders at 14 months. These findings demonstrate a repair effect as early as 7 months, but only in negative responders. This aligns with previous studies showing processing advantage for negative responders in various aspects of early language acquisition. Our research offers novel insights into the neural mechanisms of phonotactic repair in infants, emphasizing the interplay between age, neural maturation, and language-specific processing.

P1-D-56 - The role of visual speech cues on infants' neural tracking of speech

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Details

In face-to-face interactions with their caregivers, infants receive multimodal language input from both the auditory speech signal as well as the visual speech signal on the speaker's face. Visual speech cues (i.e., the rhythmic movements of the mouth, lips and jaw) have been found to modify speech perception in adults and infants (Crosse et al., 2015; Tan et al., 2022; Teinonen et al., 2008). Infants between 6-12 months may be especially sensitive to these cues as they attend more to the mouth of a talking face than the eyes (Lewkowicz & Hansen-Tift, 2012).

One mechanism argued to play a key role in speech processing in both adults and infants is neural speech tracking. This refers to the phase-locking of cortical oscillations to the amplitude envelope of the speech signal at multiple frequencies, such as the rate of stressed, syllable or phrasal units. Importantly, visual speech cues can provide additional information about the amplitude envelope of the speech signal, given the close temporal correspondence between the opening and closing of the lips and the acoustic envelope, specifically at the syllable frequency range (Chandrasekaran et al., 2009). Thus, exposure to the visual and auditory input simultaneously may aid speech processing by enhancing neural tracking of speech, particularly at the syllable rate (Peelle & Sommers, 2015).

Here, we investigated whether visual speech cues facilitate infants' speech processing, indexed by their neural tracking of speech. 32-channel EEG data was recorded from 10-month-old Dutch-learning infants while they watched videos of a native Dutch speaker reciting passages in infant-directed speech. Half of the videos displayed the speaker's full face (Audiovisual [AV] condition), while in the other half, the speaker's mouth and jaw were masked with a static block (AV-Blocked condition). We analysed infants' neural speech tracking, measured by speech-brain coherence at the stress and syllable rates (1-1.75 and 2.5-3.5 Hz respectively in our stimuli). To investigate whether infants show neural tracking of speech, cluster-based permutation analyses were performed at the stress and syllable rates by comparing real speech-brain coherence to shuffled data, created by randomly pairing the speech envelope with the EEG data. Then, differences in infants' speech-brain coherence in the AV and AV-Blocked conditions were tested with cluster-based permutation at the frequencies of interest.

Our results (N=34) indicate that infants show neural tracking at both the stress and syllable rates at all electrode sites (cluster *p*'s = .002). However, we identified no significant differences in speech-brain coherence between the Audio-visual vs. Blocked conditions, meaning that infants likely tracked the speech envelope equally well when visual speech cues were present or masked (see Figure 1).

<insert Figure 1 here>
Figure 1. (A) Scalp topography of speech-brain coherence (SBC) at the stress and syllable rates showing *t*-values of the cluster-based permutation test comparing observed SBC to surrogate data in the AV and AVb conditions. (B) Scalp topography of the difference in speech-brain coherence between the AV and AVb conditions.

These results have important implications for our understanding of early speech perception, as they suggest that neural speech tracking is a robust phenomenon already present in infancy. Furthermore, these findings show that infants' speech processing is not necessarily impaired when visual speech cues are occluded, such as when listening to a speaker wearing a face mask.

P1-D-57 - Babble development and caregiver speech in English and Ugandan babies

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Details

Literature on the role of babble production in language development is surprisingly limited, and existing work is derived almost exclusively from English-acquiring babies in the UK or North America - cultures with very similar childrearing practices, where parents interact with their babies in very similar ways (Duffy et al., 2015). Research on babble development in non-Western populations is scarce, but it does exist: in a study of the early vocalizations of babies from the USA, Mexico, Papua New Guinea and Bolivia, Cychosz and colleagues (2021) found no differences in the onset of production of canonical syllables across infants from differing cultural/linguistic groups. However, this analysis did not attempt to assess the quantity/quality of individual infants' vocalizations, nor did it take environmental input into account. This is an important question to consider, because it would allow us to understand how much of early babble development occurs as an internal process driven by cognitive, motivational/emotional and biological mechanisms, and how much is derived from external influences from the linguistic environment.

We address these key gaps in the literature by analysing the babble vocalizations of infants in relation to the quantity of caregiver input from two very different cultural settings: the UK and Uganda. Using naturalistic video recordings, we investigate the associations between infant babbling at 9 months during play, care and rest contexts, the quantity of parental speech input they receive, and their vocabulary knowledge at 18 months. We analyse, for each infant (N = 55), the amount of time spent vocalizing (measured in milliseconds, including all non-reflexive vocalizations; babble, non-babble, and laughter, but not cries, burps, sneezes, etc.), and the number of consonants produced in babble vocalizations (consonant types and tokens). To consider infants' input, we analyse the amount of speech infants hear overall (including overheard speech) and the amount of infant-directed speech (IDS; from the mother, and also all other speakers; input is measured in milliseconds). We compare these measures across cultures (UK vs. Uganda), and consider our vocalization measures in relation to amount of overheard/infant-directed input, and reported vocabulary size at 18 months.

Data coding is currently in progress. Based on previous research analysing babble across a range of populations (Cychosz et al., 2021; Oller & Eilers, 1988; Oller et al., 1995), we expect there to be no group differences in the amount of early vocalizations produced. However, given the lack of previous work in this area, we have no clear predictions regarding how the number of different consonants produced will differ across cultural contexts. Following other previous work, we expect that infants who vocalize more will have larger vocabularies at 18 months (McGillion et al., 2017). The extent to which the amount of input and the kind of input received (IDS vs. non-IDS) affects infants' vocal production is less clear; this analysis will be exploratory. In future work, we plan to examine contingency of caregiver responses to babble to see if this mediates any patterns found in this initial investigation.

P1-D-58 - An investigation of infant- and adult-directed speech in a second language

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Details

Infant- and adult-directed speech (IDS/ADS) is well-studied (Saint-Georges et al., 2013; Soderstrom, 2007), but relatively less work has focused on caregivers who use different languages when interacting with infants, which may foster distinct linguistic and cultural identities (Park, 2013). Several studies have used daylong recordings to investigate how the choice of language differs when bilingual caregivers address adults versus infants, but have mainly investigated caregivers highly fluent in two languages (i.e., simultaneous bilingual caregivers; Cychosz et al., 2021; Orena et al. 2019). In immigration contexts, multilingual caregivers often vary widely in their L2 proficiency, and so in this study, we examined caregivers (mothers and fathers) who speak Mandarin or Cantonese as L1, who were living in Anglophone Canada, and thus bilingual in English to varying degrees (see Table 1). We aimed to answer two research questions: First, whether the choice to use English or Chinese was similar in ADS and IDS: That is, whether family language policies were similar among infants or adults. Second, we also asked how L2 proficiency (in English) influences language choice when speaking either ADS or IDS.

LENA recordings of 8 families with infants aged from 10 to 19 months old (M = 14.4 ± 3.8) were made. 16 caregivers (L1: Mandarin or Cantonese; L2: English) were captured in these recordings, and after processing the recordings using LENA algorithms, we randomly selected ~5% of audio from language-dense portions of the recordings (Bergelson et al., 2019; Cychocz et al. 2021). Subsequently, human annotators were trained to tag the audio clips for their registers (IDS or ADS), identity of the speaker (mother or father), and languages spoken by caregivers (Chinese or English). In addition, demographic information, including English speaking proficiency (ESP, see Table 1), was collected using questionnaires.

Data collection and annotation is ongoing, but preliminary results show, first, that there was a weakly positive correlation (r = 0.34, see Figure 1a) between the percentage of English used in ADS versus IDS. Thus, as parents increase their use of English in ADS, this was only loosely correlated with the amount of English used when using IDS. There may be several reasons that family language policy between adults might differ compared to that for infants, and so we also asked in this preliminary analysis whether

proficiency in English might be one factor. Again, we only observed weakly positive correlations between English speaking proficiency and the percentage of English used in both IDS (r = 0.275) and ADS (r = 0.394) (see Figure 1b). Further data collection and analysis will help us understand these patterns better, as we later analyze questionnaires on ethnic orientation (Nagy et al. 2014), and parent self-reports on English use (also collected, but not yet analyzed). One implication for wider interest is whether explicit language planning (e.g., encouragement of parents to use L1 with children) may help prevent L1/heritage language loss in the next generation.

P1-D-59 - Rhythmic discrimination of languages in infants with hearing loss

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Details

Introduction: During the last trimester of pregnancy, the fetus can hear and starts to experience speech. The maternal tissues act as low-pass filters, preserving mainly the prosody of speech. At birth, newborns show sensitivity to the rhythm of their native language, i.e. the language they heard prenatally, being able to discriminate it from a rhythmically different language and the native language is triggering a greater and/or more left-lateralized brain activations (Peña et al. 2003, May et al., 2018). A current hypothesis (Gervain, 2018; Nallet & Gervain, 2021) suggests that prosody, perceived before birth, provides the basis of early speech perception and helps infants discover other linguistic units after birth, when the full-spectrum speech signal is available. Prenatal experience is thus hypothesized to be foundational for language learning. But what happens when the prenatal experience is disrupted?
Methods: To investigate this, we are testing the ability of 0-10-month-old infants with hearing loss (HL) to discriminate their native language (Italian) from a rhythmically different unfamiliar language (English). Sentences in both languages are presented forward and backward. Backward speech, with perturbed temporal features, is a standardly used non-linguistic control, matching the physical properties of forward speech overall (Peña et al. 2003). A control group of age-matched normal hearing (NH) infants is also tested. The two groups are tested using the same paradigm, and their brain activity is recorded using functional near-infrared spectroscopy (fNIRS) with a twenty-channel montage covering the frontal, temporal, and parietal regions, bilaterally. The sentences in each of the four conditions are presented in a simple block design, with the order of blocks intermixed and counter-balanced across infants. The sentences in the two languages and in the two orders of presentation (forward and backward) have been matched in intensity and duration.
Results: Data collection is ongoing. HL group: n = 22, mean age = 89 days, 11 females; hearing loss severity: 15 moderate, 2 severe, 2 profound, and 3 with unilateral HL (all infants did not have hearing aids at the time of the test). NH group: n = 28, mean age = 118 days, 13 females. Once the final sample is reached, statistical analyses will be performed to investigate whether the brain activation in response to the native language and to the unfamiliar one differs in the HL group, as well as in the control group. Comparison will be performed between the two groups of infants. Concerning the HL group, the hearing thresholds will be taken into account as a continuous variable to investigate its impact on prosodic perception. Preliminary results suggest that both NH and HL infants show positive, canonical hemodynamic responses to Italian, but inverted responses to English. Group comparisons and the

comparison of the forward and backward conditions will be also carried out.
Conclusion: If found, a deficit in prosodic perception in infants with hearing loss could provide theoretical insights into the role of prenatal and early postnatal experience in language development, as well as important applications for screening and intervention in this population.

P1-D-60 - Encoding the internal structure of syllables: evidence from infant studies and a computational modelling approach

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Details

Syllables are one of the fundamental building blocks of early language learning. Infants preferentially segment, process and represent the speech into syllable-sized units since birth (Bijeljac-Babic et al., 1993; Bertoncini et al., 1995; Fló et al., 2022) raising the question of what type of computations infants perform on these perceptual units. It has been recently shown that 4-5 month-old infants encode the internal structure of syllables such as CVC (consonant-vowel-consonant) when there is a certain degree of phonetic overlap between familiar and test syllables (Santolin et al., 2023, Exp.1). Here, we provide new evidence: infants can abstract away the internal syllabic structure when test syllables comprise new combinations of phonemes. After familiarization with strings of either CVCs (e.g., *sen*, *bil)* or CCVs (e.g., *sne*, *bli)* infants were presented with new syllables implementing both structures (e.g., kos vs. kso). Infants successfully discriminated at test, but only after being familiarized with CVC [$F(1, 46) = 4.267$, $p = .044$, $\eta^2_G = 0.023$; Figure 1]. To succeed in the task, infants must encode some abstract properties of syllables, recognizing their internal structure regardless of the phoneme combination used to implement them. This research provides new, robust evidence of abstract processing of syllabic structure in the first months of life.

To explore why only infants familiarized with CVC could encode syllabic structures, we are implementing a simple neural network trained on the same auditory stimuli infants were exposed to. Previous studies show that a computational model trained on a phoneme prediction task generated more accurate predictions for CVC than CCV syllables, pointing to a more robust encoding of CVC structures (e.g., Vroomen et al. 1998). Here we are taking a further step, probing the model on a generalization task. The model includes 256 input nodes, each receiving a specific frequency band of the audio spectrogram (Magnuson et al., 2020), 1 recurrent hidden layer with 512 LSTM units, 2 output nodes classifying the input into CVC or CCV syllables. We are probing the model by entering the same test syllables of Santolin et al. (2023, Exp. 2), and comparing the activation patterns of CVC and CCV output nodes. Successful generalization of CVC structures should lead to stronger activation of CVC node; same for CCV. We predict successful encoding of new CVC (test) syllables, mirroring the infant results. For CCV, if the model fails (as infants do), it could be due to the difficulty in encoding the initial consonant cluster (CC); if the model succeeds (unlike infants), it could be due to infants' prior experience with their native languages, in which CVC is more frequent (Levelt et al., 2000). We are exploring both possibilities by pre-training the model with different inputs: languages with increased CVC frequency (e.g., Spanish, Catalan, as in Santolin et al., 2023) and languages with increased CCV frequency (e.g., Russian, Czech). Results

from this computational research will provide new evidence of the mechanisms underlying the encoding and generalization of syllable structures.

P1-D-61 - What makes words easy to comprehend and produce?: Predictors of Korean children's acquisition of words

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Details

Vocabulary acquisition is intricately interwoven with diverse linguistic and cultural frameworks. Given the significance of input in acquiring words, it is important to understand how factors previously identified as influential in word learning manifest in different linguistic and cultural contexts. In this study, we first investigate the effects of various input factors on Korean children's vocabulary acquisition. Because grammatical features of the Korean language differ from previous examined languages, such as English or Dutch, in several ways (e.g., frequent omission of nouns, a verb-final word order, high degree of morphological complexity characterized by agglutinative inflections), it would play an important role in understanding consistency and variability across languages. Second, we investigate the reasons behind the observed reversal between noun- and verb-bias in the early lexical acquisition of Korean children, as documented by Frank et al. (2021). This investigation is conducted against the backdrop of an overrepresentation of nouns in the early lexicons across various languages. We assess how multiple factors interact with age and lexical categories, examining differences between production and comprehension.

We used vocabulary data collected using Words & Gestures (WG) and Words & Sentences (WS) forms of the Korean MacArthur-Bates Communicative Development Inventories (K-CDI) available on wordbank. Total and solo frequencies of each word in the K-CDI in child-directed speech were calculated from the Ko corpus in CHILDES. We also counted the number of inflected forms for each word in the K-CDI from the corpus. The degree of concreteness for each word in the K-CDI was assessed by 25 Korean adults using a 5-point scale, and the average score was taken.

Children's comprehension (WG) and production (WS) vocabularies were separately analyzed using generalized linear mixed-effects models. Preliminary analyses revealed that the effect of solo frequency was weaker in older children in both comprehension and production. Additionally, the effect of solo frequency varied across lexical categories; in comprehension, the effect of solo frequency was stronger in predicates and in production, it was stronger for words in the other category (see Figure 1). The production model also yielded other significant interactions. As children's age increased, the effect of concreteness also increased, but the effect of the number of inflected forms decreased. For interactions with lexical categories, the effect of total frequency was stronger in nouns and the effect of inflected forms varied across the lexical categories. Overall, the current results are consistent with previous studies (e.g., Braginsky et al. 2019; Verhagen et al., 2022), such that the effects of frequency and concreteness differ depending on age and lexical categories. The stronger solo frequency effect of predicates in comprehension seems to contribute to a verb-bias in early comprehension. Since the

majority of one-word utterances consist of verbs in Korean mothers' speech, infants in the WG stage are exposed to a substantial amount of isolated verbs and thus more likely to understand them.

P1-D-62 - Monthly variation in infants' speech-like vocalizations and cries suggest detrimental effects of financial stress

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Details

Infants' speech-like vocalizations elicit caregivers' vocal responses, promoting speech development (e.g., Goldstein & Schwade, 2008; Warlaumont et al., 2014). In contrast, infants' cries are less likely than other infant vocalization types to initiate non-overlapping adult vocal responses (Fields-Olivieri & Cole, 2019). Cries are also associated with caregivers' negative affect (de Barbaro et al., 2023). Recent research has found fewer infant-adult conversational turns at the end of the month (Ellwood-Lowe et al., 2022; Roby & Scott, 2022), when caregivers' financial concern is greatest (Salary Finance Inc., 2020). However, more nuance on infant vocalization types and caregivers' vocal responsiveness is needed to understand how time of month impacts infants' vocalizations. This study examined the amount of infants' speech-like vocalizations and cries during the last week of the month compared to the first three weeks of the month.

We analyzed 409 5-minute segments from daylong home audio recordings of 42 infants at 3, 6, 9, and 18 months old. Each recording had up to three segments per age selected based on high infant volubility. Human listeners coded onsets and offsets of infants' speech-like (canonical) vocalizations, non-speech-like (non-canonical) vocalizations, and cries. Vocalization counts were averaged across coded segments for each recording resulting in 5-minute averages from up to 15 minutes of audio at each age. Speech-like (canonical) vocalizations were only analyzed for 9- and 18-month-old infants due to their low prevalence at earlier ages.

Analyses mirrored prior research on time of month effects with longitudinal data (Ellwood-Lowe et al., 2022). Linear mixed effect models used infant speech-like vocalizations and infant cries as dependent variables with fixed effects for time of month, random effects for participant, and age as a repeated measure. Time of month was treated as a categorical variable (i.e., first three weeks: days 1-23 vs. last week: days 24+), akin to prior research. Models were fit using maximum likelihood to determine if including time of month significantly improved model fit.

Time of month improved model fit for both infants' speech-like vocalizations, $X^1 = 4.69$, $p = .03$, and infants' cries, $X^1 = 5.62$, $p = .02$, indicating that infants' vocalizations varied significantly based on time of month. For instance, 18-month-old infants produced less speech-like vocalizations during the last week of the month (M = 17.12) compared to the first three weeks of the month (M = 29.99), $t(30) = 1.86$, $p = .04$, but produced more cries during the last week of the month (M = 7.64) compared to the first three weeks of the month (M = 2.95), $t(30) = -1.38$, $p = .09$ (see Figures 1 and 2 for totals across all age groups). Results suggest that finanicial stress may influence infant vocal productions, which could have downstream consequences for communication development and infant-caregiver well-being (although other factors related to time of the month cannot be ruled out). Subsequent analyses will assess whether rates of adult vocal responses to infant vocalizations vary with time of the month.

P1-D-63 - Learning silly words: Caregiver descriptions of toddler affect as word learning opportunities.

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Details

Language learning is a difficult task for toddlers as they build associations between thousands of words and the world around them. Naturally, some words are easier to learn than others. Nouns tend to be the earliest learned words because they refer to concrete objects. Other words, like adjectives, emerge later in development. And even within the category of adjectives, certain words pose additional challenges. Whereas some adjectives reflect qualities that can be directly perceived (e.g., *"big", "red"*), other adjectives describe qualities that are less obvious (e.g., *"silly", "sad"*). To learn affect-related adjectives, infants must correctly identify emotional expressions and map them to the relevant word (e.g., when some is smiling and laughing, infants can infer that they are *"happy"*). How do infants do it?

Much like nouns, affect words are learned in the context of every-day situations during caregiver-infant interactions. We hypothesize that the social reciprocity between caregivers' affect words and infants' emotional expressions may support word learning. Specifically, we predict that caregivers use affect words to describe toddlers' emotion expressions during play (e.g., *"why are you fussy?"* as infant cries, or *"you're being silly"* as infant giggles). In turn, infants' own emotional expressions may serve as context cues that highlight the affect word's meaning. We have two aims: (1) Document the frequency and variety of affect words that caregivers use during everyday life; and (2) Test whether caregivers' affect words temporally align with infants' emotional expressions.

To document the synchrony between caregivers' affect words and their infants' emotional expressions, we transcribed video recordings of $N = 52$ caregiver-infant dyads (Ns = 20 13-month-olds, 16 18-month-olds, and 16 23-month-olds) during 2 hours of natural activity at home. Using the transcriptions, we are currently identifying every affect word that the caregivers said. We predict that affect words will be commonplace in infants' natural language experiences. Once affect words are identified, we will create 8-second video clips surrounding each affect word utterance. To establish a consensus on the infant's affect during the utterance, adult raters (undergraduate volunteers who are naïve to the study objectives) will watch each video clip and select affect words that describe the child's mood from a long list of adjectives. Once the infants' affect states have been labeled, we will look at the alignment

between caregiver affect words and the emotional expression of the infant. We predict that caregivers' affect words will frequently align with the infants' own mood. The degree of alignment between infant's emotional expression and caregiver affect words will then be compared to their performance on the MacArthur Bates CDI—a measure of the infants' overall language ability.

Understanding affect words is foundational to building social relationships, communicating about one's own and others' emotions, and to functioning in the world in general. Thus, it is critically important to identify the behavioral real-time mechanisms by which infants come to learn about affect.

P1-D-64 - Spanish-learning infants segment disyllabic verbs at 6-months

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Details

Introduction: Most research on infants' abilities to segment words from fluent speech has been on stress-timed languages like English, Dutch and German. Infants' show a somewhat different developmental trajectory when segmenting words in syllable-timed languages like French and Spanish. By 6-months, infants learning both French (Nishibayashi, Goyet & Nazzi, 2014) and Spanish (Bosch et al., 2013) successfully segment monosyllabic words. It is the segmentation of disyllabic words that seems to be more challenging in infants learning syllable-timed languages like French (Nishibayashi et al., 2014; Nazzi et al., 2006) and Spanish (Bosch, pc; Mateu & Sundara, 2021).

Participants: In two experiments we investigated whether Spanish learning 6-month-olds, monolingual (n=20) and bilingual (n=10; target=20) segment disyllabic verbs. Based on a detailed parental language questionnaire (Sundara & Scutellaro, 2011), typically-developing infants with more than 70% exposure to Spanish were included in the monolingual group, whereas those with at least 30% exposure to Spanish (but less than 70%) were included in the bilingual group.

Methods: Given previous reports that infants segmentation of words is facilitated when words are aligned with utterance edges (e.g., Seidl & Johnson, 2006), all target words were placed at the beginnings (3 times) and ends (3 times) of sentences. Infants were tested using the Headturn Preference Procedure (Jusczyk & Aslin, 1999). During familiarization, infants were familiarized with 2 of 4 target verbs (*kela, tura* or *fisa, xona*) embedded in sentences till they accumulated 45 seconds of listening time to each passage. Then in the test phase, infants heard all 4 target verbs produced in isolation in 3 blocks (4 trials x 3 blocks = 12 trials).

Analysis: Listening times to familiar and novel trials were compared statistically using linear mixed effects models with lmerTest in *R* (Figure 1). Fixed effects included the between-subjects variable familiarization condition (kela.tura vs fisa.xona), and the within-subjects variables Block (1-3) and Trial Type (familiar, novel) and all interactions; random effects included an intercept to model differences in baseline listening time differences across infants).

Results & Discussion: For monolingual infants, only the main effects of Trial Type ($F(1, 211) = 5.7$; $p = 0.02$) and Block ($F(1, 212) = 19.2$; $p < 0.001$) were significant. As shown in Figure 1, infants listened significantly longer to novel compared to familiar verbs in the test trials. A novelty preference in word segmentation experiments with natural language stimuli is unusual in infants learning stress-timed languages. However, infants learning Spanish have been reported to demonstrate a novelty preference when segmenting monosyllabic words in a similar paradigm, although at 8-months. We argue that it is the placement of target verbs aligned with utterance edges that makes it easy for even 6-month-olds learning Spanish to segment disyllabic words, resulting in a novelty preference. Preliminary data from bilinguals shows a similar pattern (Figure 1), with numerically higher listening times to novel compared to familiar test trials. The implications of our findings will be discussed for understanding the consequences of bilingual exposure as well as the emergence of word segmentation in syllable-timed languages.

P1-D-65 - Pandemic-related disruptions to the home environment and English-Spanish bilingual language acquisition

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Details

Spanish-English bilingualism maintenance in children in the United States relies on consistent exposure to both languages. Acquisition and retention of Spanish may occur first through exposure from Spanish-speaking caregivers (Surrain et al., 2018) whereas English acquisition may rely on exposure in outside settings, such as childcare centers or schools. Increased levels of chaos such as job loss, income loss, and increased caregiver burden due to the recent COVID-19 pandemic may have interrupted this exposure pattern (Gassman-Pines et al., 2020). Across the nation, 70% of childcare centers were closed (Lee and Parolin, 2021). Children may have spent more time with their caregivers, resulting in greater Spanish exposure while at the same time, less interaction outside the home may have reduced English exposure. A recent study of English-Mandarin bilingual children found that pandemic disruption to the school setting (where English is spoken) improved Mandarin, relative to English production (Sheng et al., 2021). This suggests that bilingual children who spent more time at home during the pandemic may have experienced a benefit to their native language proficiency (and a corresponding reduction in English proficiency) relative to children who remained in outside settings.

Of interest is the effect of pandemic disruption on bilingual acquisition of Spanish and English. Our preliminary sample includes nine Spanish-English bilingual children (M = 32.89 range = 20 to 40; 3F) whose parents completed the COVID-19 Family Stressor Scale (Prime et al., 2021). We focused exclusively on the childcare subscale. Four children received substantial Spanish exposure at home (M = 72.37, range = 56.25 to 80) and five received 50% or less (M = 40.36, range = 25 to 50). Partial correlations controlling for age suggest childcare disruption is negatively associated with English vocabulary scores ($r_6 = -.822$, $p = .012$) but not with Spanish vocabulary scores ($r_6 = .099$, $p = .816$). Children who experienced disruptions to childcare may have lost a source of their English exposure leading them to have lower vocabulary scores than peers whose care was undisrupted. However, Spanish vocabulary may have been protected for those children who experienced high levels of Spanish

exposure at home. Descriptively, children whose care was disrupted (n=3) had lower average English vocabulary scores than children with uninterrupted care (n=6, M=8.67 and 30.17, respectively), whereas Spanish scores were similar regardless of childcare disruption (M=26.67 and 25.71, respectively). Importantly, two children who experienced disruption received substantial Spanish exposure at home (70 and 75%, respectively) whereas one child was only minimally exposed (20%). This contributes to variability in the effect of disruption on Spanish vocabulary, limiting our ability to interpret this finding with confidence. However, the pattern for English vocabulary is clear. Children who experienced disrupted care had lower scores than nondisrupted peers. We anticipate that, with a larger sample, these findings will support Sheng et al.'s (2021) finding that disrupted childcare protected children's heritage language. Data collection is ongoing. We anticipate presenting data on 55 bilingual participants with power =.8 to detect a medium effect.

P1-D-66 - Socioeconomic status and pandemic-related chaos: A closer look at COVID-19's impact on early vocabulary

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Details

Early, stable caregiver-child interactions help shape brain architecture which support language development (Shonkoff & Phillips, 2000; Davison et al., 2023). This, in turn, predicts the development of academic skills, such as numeracy, literacy, and executive functions (Duff, 2015; Purpura, 2011; Schmitt et al., 2019; Bruce & Bell, 2022), supporting school readiness (Leffel & Suskind, 2013). Few studies have considered how the COVID-19 Pandemic altered this learning pathway. Research finds negative relations between pandemic-related disruptions and early vocabulary size (Davies et al., 2021; Kartushina et al., 2022; McGillion et al., 2023). The present study examines these relations comprehensively, utilizing a more informed measure of Socioeconomic Status (SES) and considering both magnitude and duration of disruption. We ask whether Pandemic-Related Chaos explains variance in vocabulary beyond SES and, if so, how specific types of disruptions to the home environment are related to vocabulary in children born during the pandemic.

Participants are 34 typically developing children (18F, *Mage*=28.15mos, range=19 to 44) and their caregivers. Language, health, and SES characteristics were assessed using a demographic survey. To maximize representativeness, both English and Spanish speaking families participated. Pandemic-Related Chaos (PRC) was measured via a Covid-19 Family Stressor Scale (CoFaSS; Prime et al., 2021). Items were revised to capture changes in family organization and stability due to income, anxiety, family relationship, and childcare disruptions. Vocabulary was assessed using the Web-based Computerized Comprehension Task (Web-CCT; Friend et al., 2023) and either the Receptive One-Word Picture Vocabulary Task (ROWPVT-4; Martin & Brownell, 2011; ROWPVT-SBE; Brownell, 2012) or the MacArthur-Bates Communicative Development Inventory (MCDI:WG; Marchman et al., 2023). To reduce method bias, raw scores were combined to form a language factor.

Hierarchical regression analysis examined independent contributions of SES and PRC to vocabulary. Model 1 (age and sex) was significant ($F_{2, 32}$ = 5.24, p = .029); age and female gender were positively associated with vocabulary. Model 2 (SES) and Model 3 (PRC) each significantly increased model fit from the previous model (Model 2: ΔR^2=.151, $\Delta F_{1,30}$=6.63, *p*=.015; Model 3: ΔR^2=.125, $\Delta F_{1,29}$=6.43, *p*=.016). SES consistently and positively correlated with vocabulary while in the final model, PRC negatively correlated with vocabulary. The inclusion of PRC did not reduce the effect of SES, indicating that each uniquely explain differences in vocabulary size controlling for other variables.

Relative weights analysis assessed the independent contributions of specific aspects of the home environment to vocabulary outcomes. strained family relationships and reduced access to childcare explained 65% and 16.8% of the effect of PRC on vocabulary, respectively, when controlling for age and sex. Loss of income and increased anxiety explained 10.1% and 8.1% of the effect of PRC on vocabulary, respectively. This suggests that family stability and childcare access account for greater variance in vocabulary outcomes than loss of income and increased parental anxiety. Data collection is ongoing, and we anticipate presenting data on a sample of 50 participants, with power = .89 to detect medium effect sizes of SES and Pandemic Chaos on vocabulary.

P1-D-67 - Investigating the effects of family structure on early language acquisition

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Details

Early language acquisition is crucial to the development of future cognitive processes, such as literacy and numeracy skills (Duff, 2015; Purpura et al., 2015). Disentangling the aspects of the home environment that influence early language is important for equitable healthy development. Socioeconomic status (SES), in particular, is important for accessibility to resources and opportunities, which in turn has a significant effect on cognitive development and early language skills (Brito & Noble, 2014; Lecheile et al., 2020; Kluczniok & Mudiappa, 2019). Recently, attention has turned to household density and adult-to-child ratio as potentially important indicators of SES (Poudel et al., 2023; Singh et al., 2023), however the literature is inconsistent with regard to the effect of these indicators on vocabulary. Two recently published studies on household size and vocabulary yielded contradictory results. Poudel et al. (2023) found a medium negative effect of household density and a small positive effect of adult-to-child ratio on receptive vocabulary size. In contrast, Havron et al. (2022) found no significant effect of household size on receptive vocabulary and a small effect of the number of adults in the home. We are interested in exploring the relation between household size and pandemic disruption, as well as the effect of household size and adult-to-child ratio on vocabulary in children in the second and third year of life.

Our preliminary sample includes 39 children (*M*age = 26.87 mos, range = 19 to 39, 19F, 30 English

monolingual, 9 Spanish-English bilingual). Parents completed a modified COVID-19 Family Stressor Scale (Prime et al., 2021) to assess the magnitude and duration of pandemic disruptions in income, family relations, anxiety, and childcare. Conceptual vocabulary was measured using the web-based Computerized Comprehension Task in English and Spanish (Web-CCT; Friend et al., 2023), the MCDI and IDHC (Maldonado, et al., 2003; Marchman et al., 2023), and the ROWPVT or ROWPVT-SBE (Brownell, 2012; Martin & Brownell, 2011). Partial correlations controlling for age were calculated for household size as it relates to pandemic disruption and vocabulary (a factor derived from raw scores on the vocabulary measures). Household size positively correlated with pandemic disruption (r_{33}= .353, p= .04) and negatively correlated with conceptual vocabulary size (r_{36}= -.395, p=.01), consistent with Poudel et al. (2023). Contrasting with both Poudel et al. (2023) and Havron et al. (2022), adult-to-child ratio was uncorrelated with vocabulary size (r_{36}= .067, p=.69). This likely reflects the small size and limited power of our preliminary sample. There are two findings of interest. First, the COVID-19 pandemic may have led to an increase in the number of people in the home. Second, increased household size may reflect less caregiver responsiveness to any individual child (Evans et al., 2010). If these findings hold, this information could be used for the development of effective programs and strategies for larger family households. Aid in providing a supportive environment for children is important in setting a solid language foundation for their subsequent academic achievement. We anticipate presenting complete data on a sample of 95 participants at the conference.

P1-D-70 - The role of face orientation in infancy: Investigating attentional shifts during speech perception

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Details

Developmental research has extensively tested visual attention; attentional shifts while watching talking faces are well-documented. It has been observed that infants primarily focus on the eyes up to the age of 6 months. In the second half of the first year of life, their attention shifts to the mouth (Lewkowicz & Hansen-Tift, 2012; Lozano et al., 2022; Mercure et al., 2019; Tomalski et al., 2013). This change is assumed to result from infants' increased need to acquire information about speech to support language learning.

Alongside the attentional shift, configural face processing emerges (see the review by Maurer et al., 2002). In the second part of the first year of life, infants gradually specialize in processing faces presented upright (Schwarzer et al., 2007; Cohen & Cashon, 2001). This specialization allows for rapid facial information processing, whereas face inversion disrupts the facilitation function of visual information in language processing (Rosenblum et al., 2000).

Our previous study, employing the evoked potentials (EEG/ERP) method (Szmytke et al., 2023), indicates that the specific electrophysiological audiovisual mismatch response to non-congruent vs congruent audiovisual speech is modulated by face orientation. Notably, the difference in response is age-dependent and occurs in 6-month-olds but is not present in those around 10 months. This result requires further research that includes visual attention since the mismatch response to the inverted incongruent speech occurs in young infants and adults but not in 10-month-olds.

A study on visual attention by Imafuku and colleagues (2019) indicated that 6-month-olds looked longer to the eyes in the upright condition, but during face inversion, they looked longer to the mouth. It is not clear whether mouth-looking during speech processing is affected by face orientation in older infants or whether increased mouth-looking occurs in continuous speech, not just in isolated vowels. Therefore, this study aims to investigate visual attention and the role of emergent configural face processing in audiovisual speech processing in younger and older infants.

In this ongoing study, we test infants' visual attention while watching continuous audiovisual speech in upright and inverted orientations in two age groups: 6-month-olds (n=8) and 10-month-olds (n=22). The planned sample will consist of 30 infants in each group. Infants' looking behavior when watching four 30-second videos is recorded using the Tobii T60 XL eye-tracker. The proportion of total looking time towards defined areas of interest (mouth vs. eyes) will be computed for each condition separately. Preliminary results show that both groups of infants look longer at the eyes when the face is upright compared to inverted. The analysis on mouth-looking shows a marginally significant interaction effect, indicating that in the inverted condition, younger infants look longer at the mouth than the older ones ($F(1,28)=3.40$, $p=.076$, $\eta 2=.108$). These preliminary results are promising, and the full sample will allow us to answer whether visual scanning of a speaking face differs when the face is inverted and to compare looking behavior between younger and older infants when processing inverted faces.

P1-D-71 - Cross-cultural differences in the impact of SES on children's vocabulary size: data from Japan

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Details

Family socio-economic status (SES) – especially household income and parental education – significantly impacts the early language skills and vocabulary of 18-month-old children (Fernald et al., 2013). Although other factors (e.g., mother's working status) also contribute (Laing & Bergelson, 2019), SES differences are strongly associated with variation in language outcomes in children acquiring English in the United States. To date, however, cross-cultural differences in SES impact remain unclear, and in particular, few studies have examined the effects of SES on vocabulary size of children in Asian countries.

We report results of a large-scale study of Japanese children, investigating the impact of home environmental factors on vocabulary size. A total of 436 parents from the Tokyo area completed the word and grammar portions of the Japanese MacArthur-Bates Communicative Development Inventories (JCDI, Watamaki & Ogura, 2004) when the children were 20 months old (216 girls, 220 boys). Earlier, when the children were 5 months old, the parents had completed a questionnaire about their home environment, including household income, parents' years of education and age, and mother's work status ('stay-at-home' mother, working outside the home, or on maternity leave).

The distribution of household income among participants was relatively close to that of the general population with children that age in suburban Japan (Murayama et al., 2017). The mean duration of mothers' post-primary education was 15.56 years (SD = 1.83), while fathers' was 15.79 years (SD= 2.12).

The results were first submitted to a linear regression analysis with vocabulary size as the dependent variable, and infant sex and home environmental factors as independent variables. Sex ($F(1, 431) = 19.52$, $p < .00$; girls > boys) and mother's working status ($F(3, 431) = 5.16$, $p < .00$) contributed significantly to the children's vocabulary (Table 1). In contrast, household income, parental ages and years of education did not contribute to children's vocabulary size, and none of the interactions between the independent variables were significant.

Next, we conducted model comparisons between null models that omitted mother's working status (but included infant sex, maternal education, household income and family size), and models that included the same variables plus mother's working status. Table 2 summarizes the results, which revealed that models with mother's work status provided a significantly better fit than models without maternal work status.

Our results suggest that the ways individual components of SES impact Japanese children's vocabulary at 20 months differ from those in the US. Current findings indicate that the way in which factors related to the home environment, such as household income or parental education, impact children's vocabulary size can differ across cultures and/or languages. This work emphasizes the importance of diversifying SES research to include underrepresented regions and cultures.

P1-D-72 - Development of unusual three-way affricate contrast perception in Korean infants

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Details

Data informing speech perception development theories has derived from limited types of consonants and vowels (Singh et al., 2022). Among consonants, for instance, affricates, which combine stop and fricative features, have been understudied relative to stop categories. A recent report on the two-way affricate contrast in Basque suggested that affricates present a challenge to infants because of their acoustic-perceptual difficulty, delaying the emergence of target phoneme categories until the end of the first year (Larraza et al., 2020). Korean uses unusual three-way affricate contrasts (i.e., fortis, lenis, and aspirated, e.g., /c*ata/, /cata/, /c^{h}ata/, meaning 'squeeze', 'sleep', and 'kick,' respectively), all of which are voiceless. They can be more challenging for infants because of limited category space along the durational dimension and the diachronic change in the two acoustic parameters (noise duration and fundamental frequency) between the lenis-aspirated contrast over the past decades (Lee, 2016). The present study examined the point at which Korean infants' sensitivity to three-way affricate contrasts emerges during their first year.

Using a visual habituation paradigm and natural recordings of phonemes, we found that sensitivity to the fortis-aspirated category distinction emerges the earliest among the three pairs (Figure 1). While 4–6-month-olds did not show signs of discrimination ($t(33) = .34$, $p = .74$, $d = .06$), 7–9-month-olds could discriminate them with reliably longer fixation to *switch* than *same* trials ($t(24) = 4.7$, $p < .01$, $d = .94$). The sensitivity to the lenis-aspirated contrast emerged latest, around 10–12 months ($t(32) = 3.095$, $p < 0.01$, $d = .54$). No signs of discrimination were observed among 7–9-month-olds ($t(32) = 0.59$, $p = 0.57$, $d = .10$).

The sensitivity to the fortis-lenis contrast had not yet appeared in 4–6-month-olds ($t(17) = 1.09$, $p = .29$, $d = .26$) either, suggesting that it may appear later like other category distinctions, but data collection for this contrast is ongoing. To verify whether the naturally produced phonemes in our study were discernable, 25 Korean adults undertook an identification task, resulting in overall high identification accuracy: 98% for fortis, 92% for aspirated, and 89% for the lenis category.

These results are similar to findings on Basque affricates and Korean stop category emergence patterns (Choi et al., 2023), lending additional support for the gradual emergence of native phoneme categories and lack of early sensitivity to them. Notably, compared with Korean three-way stop contrasts, sensitivity to affricates appears to develop even later because Korean 4–6-month-olds showed no signs of distinguishing any of the three contrasts. The sensitivity to the fortis-aspirated distinction emerged after approximately 7 months of age, in contrast to stops at 5 months (Choi et al., 2020). This delay in development suggests that acoustic subtlety plays an additional role, as proposed by Larraza et al. (2020), but unlike Sundara et al. (2018). Further investigations are currently underway, looking at the role of maternal phonetic input in developing sensitivities to affricate categories by examining the relationships among acoustic parameters provided by mothers, and their infants' differential sensitivity to these categories.

P1-D-73 - Evaluating an infant/child language development knowledge mobilization activity in a museum-based Living Lab

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Details

In addition to researchers conducting studies in traditional university-based individual labs, teams of researchers are now partnering with museums and community centres to create Living Labs focused on conducting research directly in the community and on transmitting research knowledge [i.e., knowledge mobilization (KM)] to community members. Our infant and child development Living Lab is in partnership with a science museum and has two main objectives: participant data collection (from 3 months to 8 years of age) and KM. KM benefits the public; researchers are available to discuss infant/child development findings and answer questions about the research process. We recently created a KM activity for museum visitors to engage with: a bus-shelter-sized poster containing facts about language development and parent-led and child-centred activities tied to phoneme recognition (e.g., highlighting rhymes to infants/children). The poster was inspired by the Learning Landscapes movement where researchers "change the architectural design of [cities] to infuse them with learning potential by adding puzzles that build science, technology, engineering and math (STEM) skills" (Golinkoff, Learning Landscapes website). We wished to determine the poster's KM efficacy by focusing on adult and child engagement with and learning from the poster. Three key methods have been used to analyze the efficacy of KM activities in a museum/playground setting: surveys (Michaelson, et al. 2021), observations (Hassinger-Das et al., 2019), and interviews (Lussenhop et al 2013). We implemented a survey method as the measure of efficacy of our KM activity (all study materials available on osf).

We collected data via a longer survey for adults with infants, toddlers and young children delivered via iPad (N = 55). We also had a short survey for adults (78 responses) and children (163 responses) available beside the poster, where responses were placed in a box. The long survey consisted of 27 questions using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Most respondents meaningfully engaged with the activity (86%; percentages reflect the amount of participants who strongly agreed or agreed to the relevant subset of questions - see Figure 1 for example); moreover, they positively indicated that: they found the activity interesting (92%); the activity increased their confidence to engage in sound awareness activities with their infant/child (91%); and they would be very likely to share the new knowledge with others (76%). The short "Box" survey consisted of two adult questions (engagement and learning) and two child questions (engagement) with a simplified picture response Likert scale (see Table 1). Most adults (82%) and children (59%) liked the activity and most adults (74%) learned something new about infant/child development. A comparison of adult and child answers to question 1 (like) showed no difference in average score (adults $M = 2.68$, children $M = 2.48$; $t(129) = 1.56$, $p = 0.12$).

This activity can easily be translated into other languages and placed in different locations for a simple and effective knowledge mobilization activity. We are currently modifying the poster based on qualitative feedback and are planning to place the poster in bus-stop-shelters.

P1-D-74 - Infant-directed speech and the role of positive affect: Analysis of amplitude modulations

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Details

Infant-directed speech (IDS) is a well-documented speech register that facilitates speech perception for infants. Compared to adult-directed speech (ADS), this speaking style usually has a slower speaking rate, higher pitch, and conveys extensive positive affect (Polka & Ruan, 2021).

Speech perception in infants relies heavily on cortical entrainment with the speech signal. This entrainment involves the synchronization of auditory neural oscillations and amplitude modulations (AMs) in speech. Speech AMs occur at different rates corresponding to different oscillatory bands, including delta, theta, and beta bands. IDS has more energy at slower AMs than faster AM rates, while the reverse pattern was observed for ADS (Leong et al, 2017). There is also higher synchrony between slower-occurring modulations (corresponding to delta and theta rates) compared to faster-occurring modulations for IDS.

In this study, we explore what underlies these acoustic profiles. Considering that infants are attracted to positive vocal affect, whether it is conveyed through ADS or IDS (Singh et al, 2002), we hypothesized that positive affect might generate these AM rate patterns. Thus, similar AMs might be present when comparing happy and neutral ADS.

To test this, we conducted a study with two stages: first, we set out to replicate (Leong et al, 2017) by employing the same analysis approach using IDS and ADS recordings from the Many Babies Corpus

(Frank et al, 2020). This corpus includes the speech recordings of 15 mothers (native North American English [NAE]) speaking to a 4-to 8-month-old (IDS) and to an adult (ADS). We analyzed 181 speech segments from this corpus. Second, we did the same analysis comparing happy and neutral ADS using validated recordings of 4 native NAE speakers (2 males and 2 females) conveying these emotions (Pell et al, 2009). We analyzed 120 speech segments from this ADS corpus. Using the Amplitude Modulation Phase Hierarchy method (Leong & Goswami, 2015), we extracted the AMs of the recordings at rates synchronous with delta, theta, and beta oscillations and computed the Phase Synchronization Index to measure the synchronization across adjacent modulation rates.

Our comparison of IDS and ADS did not replicate Leong's findings, likely due to the short duration of our stimuli. However, our comparison of happy and neutral ADS showed the same patterns Leong observed when comparing IDS and ADS. Specifically, in the delta band (slower rate, 0.9-2.5 Hz) happy ADS had significantly higher energy than neutral ADS ($p < 0.0001$). We also found that higher synchronization occurs between theta and beta bands (faster rates, 2.5-40 Hz) for neutral ADS compared to happy ADS ($p < 0.0001$). These findings suggest that positive affect might create specific AMs in the speech signal that attract infant attention and allow infants to track slower-occurring rhythms (e.g. prosody) easier than faster-occurring information (e.g. syllable). This study is the first to analyze the temporal modulations related to vocal emotion and our findings provide new insights into the novel features of infant directed speech, enhancing our understanding of infant speech perception.

P1-D-75 - Improving continuity and scale: Introducing the Spanish web-based computerized comprehension task

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Details

Early vocabulary plays a fundamental role in children's language and cognitive development. During the first five years of life, children establish word-to-world mappings that support literacy, influencing school readiness and future outcomes (Leffel & Suskind, 2013). This development is important to track given its importance to long-term developmental outcomes. However, there are few vocabulary assessments for Spanish-speaking children beyond the first two years of life. Further, some Spanish assessments are direct translations from English jeopardizing their cultural relevance and developmental validity for children learning Spanish (Kester & Pena, 2002). This may limit the accuracy of the assessment for children learning Spanish as either their first or second language.

Following the original Computerized Comprehension Task (CCT; Friend & Keplinger, 2003, 2008) and its expansions (Bleses et al., 2021 in Denmark, Gillen et al., 2021 in the UK, and Rosemberg & Alam, 2021 in Argentina), we have extended this assessment to create the Spanish Web-Based Computerized Comprehension Task. The Spanish Web-CCT is a two-alternative forced choice automated procedure where the target-distractor pairs match on difficulty, semantic category, word class, and visual salience. Words were selected from the Inventarios del Desarrollo de Habilidades Comunicativas: Palabras y Enunciados (IDHC:PE, Jackson-Maldonado et al., 2003), IDHC-III (Jackson-Maldonado, unpublished), and an Argentinian Corpus (Rosemberg, 2015). We focused primarily on words that were universally known

by children learning Spanish across regions and dialects based on AoA ratings and language corpora (Alfonso et al., 2015; Diez-Itza et al., 1999, Romero et al., 1992). The words were then reviewed by native Mexican Spanish speakers for cultural appropriateness and relevance to our regional context. We designed the Spanish Web-CCT to estimate vocabulary from 18 months to 60 months of age, which will improve continuity. The assessment is also web-based, which will improve scalability. We predict that scores on the Spanish Web-CCT will be positively associated with age, that it will correlate positively with the Receptive One-Word Picture Vocabulary Test Spanish-Bilingual Edition (ROWPVT-SBE; Brownell, 2012), that children will show good test-retest reliability, and finally, that the items will evince high internal consistency.

We will present our findings on the psychometric properties of the Spanish Web-CCT. We ran a series of bivariate correlations and intraclass correlation analysis. The Spanish Web-CCT showed the expected positive correlation with age (r_{17}=.600, p=.008), convergent validity with the ROWPVT-SBE (r_{12}=.848, p=<.001), and good test-retest reliability (r_{11}=.771, p=.003). Finally, internal consistency of the instrument is excellent (α = .974).

P1-D-76 - The caregiver speech of the 6- to 13-month-old infants in Iran

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Details

Investigating the linguistic environment, including the adult caregiver speech to which infants are exposed, plays a vital role in language development of infants. While there is extensive research on caregivers' speech to infants in Western cultures, the characteristics of caregiver speech to infants in non-Western, particularly Middle-Eastern cultures, remain underexplored (Henrich et al., 2010; Nielsen et al., 2017). Our research aims to bridge this knowledge gap by analyzing the speech from adult speakers, particularly female adult caregivers to infants in Mashhad, Iran. Utilizing the Language ENvironment Analysis (LENA) System (Gilkerson & Richards, 2008) for audio capture and analysis, we created a dataset including naturalistic longform home audio recordings from the language environment of n = 50 (mean age = 9 months and 22 days, ranging from 6- to 13-months), as well as annotations of these audio recordings.

Our preliminary evaluations assessed the relationship between Persian infants' age and gender, and the total amount of speech they received from adults (Adult Word Count = AWC). A linear regression indicated a non-significant relationship between infant age and AWC (p = 0.151) as well as infant gender and AWC (p = 0.747). Moreover, results of a paired-samples t-test revealed that Persian infants heard significantly more speech from female (mean = 84.82) than male (mean = 17.98) adult speakers (p < 0.001). This suggests the prevalent role of female caregivers in the linguistic development of infants in Iran, aligning with findings from previous research (Bergelson et al., 2019). Additionally, the results from a linear model indicated that neither family income (p = 0.533) nor caregiver's education level (p = 0.508) had a significant association with AWC.

Our ongoing analyses are delving into the prosodic characteristics of the caregiver speech directed to Persian infants, such as pitch and pitch range, via annotation and acoustic analysis. Our study enriches the field of developmental psychology by integrating data from an understudied non-Western population, thereby offering a broader perspective of the linguistic environment affecting Persian infants at a crucial stage of their language development. Our findings not only provide empirical data from a non-Western context but also have the potential to refine theories of language acquisition, suggesting that cultural variations in caregiver-infant interactions may influence early language development in nuanced ways.

P1-D-77 - Children's language experiences across activity in inclusive preschool classrooms

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Details

Young children's early language experiences unfold during the everyday activities that structure their worlds. Infant's language output and input from caregivers varies across different activity contexts (Custode & Tamis-LeMonda, 2020; Soderstrom & Wittebolle, 2013; Tamis-LeMonda et al., 2019). Preschool teachers use activities to organize the day and give children opportunities to engage with tasks and socialize (Mashburn et al., 2008). Preschool/early-intervention classrooms are important contexts for children with typical development (TD), autism spectrum disorder (ASD) or developmental delay (DD). Individual differences, such as disability group membership and time spent in different activity contexts, may be an important source of variability relating to children's classroom language experiences. However, it remains unclear how children's language experiences vary across classroom activities and what consequences individual variation has for the developing language abilities of children with TD, ASD, and DD. We use objective measures of children's classroom language experiences to describe children's vocalizations and teacher input across structured and unstructured activities and diagnostic groups and examine associations with children's expressive and receptive abilities.

Participants included 74 preschoolers (M_{age}=42.57 months, *SD*=7.02) enrolled in 8 inclusive classrooms for children with ASD (*N*=24), DD (*N*=22), and TD (*N*=15) and their teachers (*N*=10). Sixty-five children were Hispanic (61 White, 1 Black, and 1 multiracial) and 9 children were non-Hispanic (8 White and 1 Black). During each data collection day, children and teachers' vocalizations were recorded using Language ENvironment Analysis (LENA) audio recorders and trained research assistants observed and coded the beginning and end of classroom activities, classified as either structured (story-time, circle-time, organized play) or unstructured (meal/snack-time, free-play, outside-play; Perry et al., 2018; Soderstrom & Wittebolle, 2013). Linear mixed-effects models, where observations were nested in children and classrooms, were employed to predict rates of children's vocalizations, teacher input, and teacher-child turn count (TC) from activity (structured, unstructured), group (ASD, DD, TD), and an interaction between activity and group.

Overall, children vocalized at higher rates during unstructured activities compared to structured, p=.013. Additionally, there was no main effect of diagnostic group, but a significant interaction between activity and group. Children with TD and DD showed higher rates of vocalizations during unstructured compared

to structured, p<.0001 and p=.004, but children with ASD did not, p=.071 (Figure 1a). Children received higher rates of teacher input and teacher-child TC during structured activities, ps<.0001. Additionally, a significant interaction between activity and group, revealed children with ASD showed a larger difference in teacher input and TC across activities compared to children with DD, p=.024 (Figure 1b) and p=.003 (Figure 1c). We did not find associations between language experiences across activities and children's receptive or expressive language abilities.

Results show that children's classroom language experiences differ across structured and unstructured activities. Notably, individual and group differences can be seen for children even in the same classroom. Findings indicate that activity contexts are an important source of variation for early language experiences of children with ASD, DD, and TD, which may help inform education practices that support teachers' use of language in the classroom.

P1-D-79 - Canadian but not Chinese infants exhibited the McGurk effect

Rachel (Xinyang) Liu [1], **Linlin Yan** [2], **Anushka Goyal** [1], **Shuaike Hu** [2], **Anna Krasotkina** [3], **Gabriel (Naiqi) Xiao** [1]

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Details

Speech perception is multisensory: we depend both on heard speech sounds and seen mouth movements to obtain a more accurate speech perception when interacting face-to-face. The McGurk effect exemplifies such audiovisual integration. For example, when seeing the mouth articulating the syllable /ga/ matched with the sound /ba/, we would perceive an illusory /da/.

Previous research focusing on the cultural differences of the McGurk effect proposed conflicting findings. Some revealed that Asians demonstrated a lower frequency of perceiving such integrated speech sounds than non-Asians (e.g., Burnham & Lau, 1998), while others argued no such distinction (e.g., Magnotti et al., 2015). Whichever the case was, these studies all focused on children and adults. Therefore, to our knowledge, it is unclear whether this potential cultural disparity is shaped by linguistic experience or is an initial mechanism that emerged in infancy. To this end, the current study uses a perception task to investigate Asian and Caucasian infants' ability to integrate auditory and visual speech sounds.

Twenty-four (6-12 months, 8 females, $Mean_{age}$ = 8.55 months) Canadian English-learning infants and thirty-three (6-12 months, 14 females, $Mean_{age}$ = 9.64 months) Chinese Mandarin-learning infants participated. In each trial, they heard the same syllable repeating twenty times at the pace of 1s/iteration. These sounds were dubbed with videos of a female face articulating a particular syllable. These videos were interleaved by a still face image to generate a "moving-still-moving-still" pattern. Should infants perceive the McGurk effect, their auditory perception would be modified during the moving- instead of the still-face sections, leading to the percept of two alternating sounds. Otherwise, they would hear the same sound repeating.

We designed the alternating trials using the McGurk stimuli (audio /pa/-visual /ka/ or audio /ba/-visual /ga/) and the non-alternating trails with non-McGurk stimuli (audio /ka/-visual /pa/ or audio /ga/-visual /ba/). We predicted that Canadian infants would show a more salient preference for the former than the latter trials compared with their Chinese counterparts. To test this hypothesis, we used infants' overall looking time as the dependent variable. To rule out the potential other-race effect on the McGurk effect (Ujiie et al., 2021), we used videos of Asian and White female faces for Chinese and Canadian participants, respectively.

As shown in Figure 1, Canadian infants looked longer in the alternating than the non-alternating trials (*paired t*-test, p=.034) while Chinese infants did not show such preferential looking (*paired t*-test, p=.867). Chi-square tests rendered evidence supporting the same finding that Canadian (p=.041), but not Chinese (p=.862) infants, exhibited the McGurk effect.

In summary, the current study suggests that Canadian infants demonstrate earlier, if not stronger, McGurk effect than their Chinese counterparts. This contrast suggests that the ontogeny of cultural differences in the McGurk phenomenon: instead of subjecting to their disparate linguistic experiences, Chinese and Canadian infants differ in their initial mechanism in audiovisual speech integration ability. This finding provides empirical evidence for the early onset of cognitive enculturation, such as the attenti

P1-D-80 - All eyes on word comprehension: A comparative analysis of infant looking-while-listening measures

Andrea Sander-Montant [1], **Krista Byers-Heinlein** [1], **Laia Fibla** [1]

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Details

Word comprehension is especially difficult to measure in infants because they cannot yet label images or correctly point to an image in a book as older children can. To try to ascertain what words infants know, researchers have developed tasks such as the looking-while-listening (LWL) procedure, where infants see two images on a screen and hear one of them labeled while their eye gaze is recorded. However, LWL studies vary in the specific parameters used to assess word comprehension from looking, leading to multiple outcome measures being reported in the field. For example, *time spent looking* at the labeled image is usually reported as an indicator of word comprehension accuracy, while the *speed* at which infants look at the labeled image is usually reported as an indicator of word processing efficiency. These differences bring a new research problem, as it is unknown, firstly, whether the different variables are measuring word comprehension in similar ways, and secondly, whether they are all equally good measures. We bridge that gap by comparing 5 LWL word comprehension measures (see Table 1) previously reported in the literature. Our approach is to examine associations across different word comprehension outcome measures and potential predictors, to determine whether different outcome variables are measuring similar word comprehension constructs or not.

Preliminary results of correlation analyses (See Figure 1) examining associations among 5 LWL word comprehension outcome measures across 5 datasets (155 children, 14-48 months, M = 24.26, SD = 8.11, 63 female) show that not all measures are uniformly related. While most correlations were statistically significant, their magnitude varied. We found a strong positive association between the total amount of

looking to target and the proportion of looking to target (r=0.82, p<.001); a moderate positive association between the duration of the first look to target and the latency to switch from distractor to target (r=0.54, p<.001); and a moderate (although expected) negative association between the latency to switch to target and both the proportion of looking to target (r=-0.64, p<.001) and total looking to target (r=-0.57, p<.001). All other associations with age and language exposure, including with the number of switches from target to distractor, were smaller than r=0.5. These early results show a clustering tendency where some variables are likely measuring more similar constructs than others. For example, total and proportion looking might be relatedly measuring word comprehension accuracy while first look duration and switching latency might be measuring speed of processing instead. Finally, our results indicate that the associations between the outcome measures and age and exposure are not as straightforward as between two measures, likely due to the moderation of other predictors or to individual variability. Further data analyses will a) extend these analyses to an additional 24 archival datasets available through Peekbank, and 6 additional outcome measures, to examine the robustness of the results, b) deeply analyze how different outcome measures interact with age and language exposure, and c) examine effect sizes and reliabilities of different measures.

P1-D-81 - Pupil dynamics widen understandings between word learning and interest

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Details

Infant word learning is a crucial process that is of great importance to early development, with delays in early word learning being linked to poor language and educational outcomes, including Developmental Language Disorder (DLD). However infant word learning is highly variable, and the correlates of successful and delayed early word learning are not well understood. Infants are now assumed to have an active role in their vocabulary development rather than just being passively exposed to new words. Word learning for categories and novel objects was found to be quicker when a child had a greater interest for both the category as a whole and specific objects independently (Ackermann et al, 2019). Furthermore, when curiosity in infants was manipulated, by displaying blurred and clear images, curiosity was found to enhance word learning (Chen et al, 2022). Therefore, in our research we investigated the role of individual temperament in word learning, examining the dynamic interplay between category interest, general curiosity, willingness to engage, and motivated word learning using a novel word learning task and employing pupillometry. Therefore, changes in pupil diameter were used as the dependent variable. We aimed to recruit 40 children aged between 0 and 4 years to participate in our novel word learning task where they were exposed three different blocks of trials. The first block measured their interest in different categories by exposing them to scrambled images which resolve to either blurred or clear images. The second block then teaches them the names of novel objects using congruent verbal labels. Finally, in a test phase, object images were shown alongside congruent and incongruent labels. If the participant had correctly learnt the objects they should look longer and have a larger pupil size when the object is paired with an incongruent label due to a novelty preference. Caregivers also filled in questionnaires about their child's category/object interest as well as their temperament. Initial data suggests category interest to be a key factor in early word learning, supporting previous findings from Ackermann et al (2020). Differences in temperament also contributed

to word learning, indicating that the learning of novel words during infancy may be related to individual differences. This evidence supported the suggestion that infants have an active role in shaping their language environments.

P1-D-82 - Cross-dialectal differences between stress vowels in English infant-directed speech

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Details

North American English-learning infants have higher vocabulary scores than British infants (Hamilton et al., 2000). What's more, North American infants can also detect target words (or pseudo-words) embedded in sentences than their British counterparts (Floccia et al., 2016; Nazzi et al., 2014). However, it is unclear why this asymmetry exists. Perhaps the linguistic composition of a specific dialect differs in how infant-directed speech (IDS) is manifest. That is, does the use of specific characteristics (in this case, stress vowels) in IDS differ across dialects of English?

We have recruited English mothers with their 18- to 24-month-old infants from the UK (n = 12) and Canada (n = 13). Once the mother and her child are comfortable in our 2.3m x 2.4m attenuated booth, we clip a lapel microphone on the mother's shoulder so that she, and her child, could move around in the booth. The experimenter will start the recording while explaining her instructions. We ask the mother to engage with their child while reading the short stories and using spontaneous speech and the experimenter will leave the booth. The mother has 3 stories and each story has 6 sentences. Each sentence has an embedded target animal (e.g., monkey). In the story, there are 2 initial sentences, 2 medial sentences, and 2 final sentences. For example, "*One day, a small horse walked up to the curious* ***monkey***." The mothers' recordings were analysed for vowel pitch (Hz) and duration (ms). We analyzed each stress vowel for different animals such as 'monkey' [ˈm**ʌ̃**ŋ.ki], elephant [ˈ**ɛ**.lə.ˌfant], and chicken [ˈt͡ʃ**ɪ**.kə̃n]).

We predict that Canadian mothers will use higher pitch more often than British mothers when speaking in IDS. We have gathered datapoints from Canadian (n = 142) and British mothers (n = 109) and we will complete the data gathering within a few weeks. We have measured stressed vowels for each target animal embedded in a sentence. Preliminary independent t-tests were conducted. The current findings show that Canadian mothers produce higher mean pitch (see Table 1, p >.001) and higher maximum pitches (p >.005) than British mothers. Furthermore, we are currently analyzing IDS data between focus marking and non-focus targets (Fernald & Mazzie, 1991). As found in our preliminary results above, while both Canadian and UK mothers mark a focused word with an increase in pitch. However, Canadian mothers have a more exaggerated increase in IDS (*M:* 286.6 Hz; *SD:* 93.3 Hz) than their counterparts (*M:* 247.3 Hz; *SD:* 54.0 Hz, $p < .05$, $d = 0.49$).

These preliminary results may suggest that the mothers' dialects, whether British or Canadian, have different tendencies for speaking to their children. In this study, we have been investigating the differences between dialects of infant-directed speech. Specifically, we are interested in how dialects become varied over time. Further research will be conducted to detect the interactions between dialects (UK, Canada), sentence position, and focus marking.

P1-D-83 - Disrupted or delayed? Stress Discrimination Among Preterm as Compared to Full-Term Infants: An ERP study

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Details

Background

Several papers pointed out that the language disorders are the most commonly reported cognitive deficits of the preterm (PT) infants. However, neither the exact interpretation (disrupted or delayed) of their language development nor the most powerful perinatal risk factors have been specified yet. The prenatal start of prosodic tuning may affect the processing of word stress, an important suprasegmental feature of spoken utterances. Only a few studies have investigated the prosodic processing of PT infants during the first year of life.

Aims

We aimed to determine whether postnatal development of prosodic processing of PT infants is disrupted or delayed in the first year of life? We also tested the role of Birth Weight (BW) and Gestational Age (GA) regarding the PT and full-term (FT) infants' language perception.

Method

We registered the mismatch responses (MMR) of 34 PT (at 4 and 10 month of corrected ages) and 33 FT infants (at 4 and 10 month of age) elicited by bisyllabic pseudo-words in two oddball conditions by switching the stress pattern (legal vs. illegal) and role (standard vs. deviant).

Result

Contrary to their FT peers, younger PT group detected stress changes of the legal stress form only. Analogously, a positive MMR (P-MMR) was found for the legal form discrimination exclusively in PT12 group. Furthermore, the lack of sensitivity to the standard vs. deviant difference was identified in the PT infants. In PT infants, BW explained 21% of the total variance of the P-MMR.

Conclusion

Consequently, we argue that the stress sensitivity of the PT infants is unimpaired, but their stress processing seems to be disrupted from the 4th month on. We suggest for further studies to take BW into account in studies using MMR paradigms in PT infants. Intra-uterine exposition to prosodic features appears to contribute to the emergence of stable long-term stress representation. When this tuning is missing it is considered a risk for the language acquisition process.

P1-D-84 - Intergenerational associations between parental reading/musical traits, infants' auditory processing and later phonological skills

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Details

The intergenerational transmission of language/reading and musical traits has been suggested by evidence reporting that parental literacy and musical abilities contribute to the prediction of their offspring's skills in these domains. The "Musical Abilities, Pleiotropy, Language, and Environment" (MAPLE; Nayak et al., 2022) framework proposed that language/reading and musical traits share a common genetic architecture, and such shared components have an influence on the heritable neural underpinnings of basic-level skills underlying musical and language traits.
In this study we investigated the intergenerational transmission of parental musical and language-related (reading) abilities on their offspring's neural response to a basic auditory stimulation (neural intermediate phenotype) and later phonological awareness skills, including in this complex association pattern the mediating effect of home environment.
176 families were involved in this study. Through self-report questionnaires we assessed parental reading abilities and musicality, as well as home literacy and musical environment. Offspring were involved in a longitudinal study: auditory processing was measured at 6 months of age by means of a Rapid Auditory Processing electrophysiological paradigm, and phonological awareness was assessed behaviorally at 5 years of age.
Intergenerational longitudinal associations were investigated through mediation analyses using structural equation modeling. For reading traits (see Figure 1A), results revealed that paternal reading was indirectly associated with children's phonological awareness skills via their electrophysiological MisMatch Response, reflecting early auditory processing skills, at 6 months of age; on the other hand, maternal reading was directly associated with children's phonological awareness. Specifically, better paternal reading skills predcit higher amplitude of the infants' MisMatch Response, which, in turn, leads to higher phonological awareness scores at 5 years of age.
For musical traits (see Figure 1B), we found again that paternal musicality, rather than maternal characteristics, was associated with children's phonological phenotypes: in this case, the association was mediated by the musical environment. Specifically, fathers with higher musical aptitudes provide richer musical environment to the children in their first year of life, which, in turn, positively influences children's phonological awareness skills.

These results provide some insight about the intergenerational pathways linking parental reading and musical traits, neural underpinnings of infants' auditory processing and later phonological awareness skills. Besides shedding light on possible intergenerational transmission mechanisms, this study may open up new perspectives for early intervention based on environmental enrichment.

P1-E-85 - Links between caregiver stress and child language abilities in infants with autistic and non-autistic older siblings

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Details

Understanding individual differences in language acquisition in autism is a top research priority, as early language ability predicts long-term outcomes in individuals on the autism spectrum[1]. My prior work has shown that perceived, caregiving-related stress is related to language outcomes in infants who are known to be at increased familial likelihood for autism based on their status as younger siblings of autistic children (i.e., Sibs-autism)[2]. The present study aims: (1) to expand the measurement of caregiver stress and test mean differences in perceived *and* objective stress in caregivers of Sibs-autism and caregivers of infants with older, non-autistic siblings (i.e., Sibs-NA); and (2) to assess concurrent associations between caregiver stress, caregiver linguistic input, and infant language.

Families are being recruited at infant age 12-18 months for a longitudinal study of early language development in Sibs-autism and Sibs-NA. Seventy-five infants have been recruited with a full sample size of 100 expected by the time of the conference. All families speak English as their primary language. Perceived caregiver stress is measured via the Parenting Stress Index (PSI)[3], and objective caregiver stress is measured via the Assessment of Parent and Child Adversity (APCA)[4]. Adult word count (AWC; an estimate of quantity of caregiver linguistic input) is being measured by Language ENvironment Analyses recorders across two recording days[5]. Concurrent language abilities are being assessed using aggregate receptive and expressive language scores derived from the Vineland Adaptive Behavior Scales[6], the Mullen Scales of Early Learning[7], and the MacArthur Bates Communicative Development Inventories: Words and Gestures checklist[8]. To address Aim 1, t-tests will be run evaluating group differences in the degree of perceived (PSI) and objective (APCA) stress that caregivers report experiencing. To address Aim 2, regression models will be run evaluating relations between (a) the PSI and AWC, (b) the APCA and AWC, (c) the PSI and infant receptive/expressive language, and (d) the APCA and infant receptive/expressive language.

In preliminary analyses testing effects for perceived stress (in n = 58 for whom data have been entered), caregivers of Sibs-autism and Sibs-NA significantly differed in mean PSI scores (t = 3.18, p = .003, Cohen's d = 0.87). PSI scores were significantly associated with concurrent receptive language but varied according to group, such that this relation was stronger in the Sibs-autism versus Sibs-NA (p value for sibling group x caregiver stress term in model testing concurrent associations = .01). PSI scores were not significantly associated with concurrent AWC (p = .16, r = -

.18). Additional analyses will be run in advance of the conference to assess effects related to objective stress (i.e., APCA scores) and concurrent AWC and language.

These preliminary findings suggest that caregiver stress is elevated in caregivers of Sibs-autism and linked with concurrent child language, especially in infants at elevated familial likelihood for autism. Given that Sibs-autism are highly likely to go on to have language disorder, the consideration of caregiver factors that influence language acquisition may be particularly important. Implications for research, theory, and clinical practice will be discussed.

P1-E-86 - Dyadic coordination of infant behaviours and caregiver responses best predict child vocabulary

Anika van der Klis [1], **Caroline Junge** [2], **Frans Adriaans** [1], **René Kager** [1]

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Details

Children show large individual differences in their vocabulary development. There is robust evidence that infants' gestures on the one hand (Brooks & Meltzoff, 2008; Choi et al., 2021), and caregivers' contingent responses on the other hand (Masur et al., 2005; McGillion et al., 2013), individually predict child vocabulary. Recent studies suggest that dyadic combinations of infant behaviours and caregiver responses are more robust predictors of child vocabulary than individual behaviours (Donnellan et al., 2019; Lopez et al., 2020). We aimed to assess whether different combinations of infants' vocalisations and gestures coordinated with caregivers' verbal and multimodal responses during free play improves the predictive value of infant behaviours for explaining variation in children's vocabulary outcomes. This was the first study systematically contrasting the predictive value of different types of caregivers' responses.

We examined 114 Dutch infants (65 females) at 9–11 months (M = 10.7) and their caregivers (90 mothers; 24 fathers) during six minutes of free play and children's concurrent (N-CDIs) and longitudinal (N-CDIs and PPVT-III-NL) vocabulary outcomes at 2–4 years of age (M = 2.7). Using robust linear models, we compared the predictive value of three subsets of predictors: 1) frequencies of infants' individual behaviours (vocalisations, points, and shows+gives) regardless of caregivers' responses, 2) frequencies of infants' behaviours met with caregivers' verbal responses, and 3) frequencies of infants' behaviours met with caregivers' multimodal responses for children's vocabulary outcomes. Caregivers' responses were both semantically and temporally contingent on infants' behaviours. Caregivers' multimodal responses included all contingent verbal responses that were at least partially overlapping with nonverbal behaviours, including gestures, facial expressions, or other bodily movements.

After controlling for age and maternal education, we found that infants' points related to children's later receptive vocabularies measured with the PPVT-III-NL ($b = 2.48$, $p < .001$), while infants' shows+gives (i.e., a combined category including shows and gives) related to children's later expressive vocabularies measured with the N-CDI – only when taking the instances that were coordinated with caregivers' multimodal responses into account ($b = 5.98$, $p < .05$). We also found that only infants' shows+gives which elicited verbal or multimodal responses from caregivers were related to infants' gesture

repertoires measured with the N-CDI (b = 1.53, p < .001; b = 1.20, p < .01), respectively). Infants' vocalisations were not significantly related to children's vocabulary outcomes regardless of caregivers' responses.

We have provided evidence for the predictive value of infants' deictic gestures, including points and shows+gives, measured at a very young age (9–11 months) on children's long-term vocabulary outcomes (2–4 years). We showed that the predictive value of infants' gestures can differ depending on the types of caregivers' responses they elicited. The results suggest that infants' points tend to elicit verbal responses from caregivers which facilitate children's word comprehension skills, while infants' shows+gives tend to elicit multimodal responses from caregivers which facilitate children's word production skills. The results suggest that specific dyadic combinations of infants' gestures and caregivers' verbal and multimodal responses are more robust predictors of children's vocabulary outcomes than infants' gestures alone.

P1-E-87 - The influence of prenatal language exposure on the melody of infant vocalisations: A systematic review

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Details

Introduction: During the last trimester of pregnancy, foetuses have access to auditory stimuli such as the melodic patterns of maternal speech. Newborns' remarkable *perceptual* sensitivity to such prosodic information exposed to prenatally have been demonstrated, thereby supporting the notion that the acquisition of native language prosody may have a prenatal origin. Fewer efforts to study the role of the prenatal period in the learning of native prosody have been made from a *production* perspective. Furthermore, the inferences made regarding whether prenatal language exposure influences early speech production such as cry and non-cry vocalisations, vary across available studies. Therefore, our review aimed to systematically describe and critically appraise the study characteristics and outcomes of available studies by asking: *Is the prosody of infants' early vocalisations influenced by prenatal exposure to the prosody of their native language?*

Method and study population: We conducted a systematic review of quantitative evidence in accordance with the PRISMA (Shamseer et al., 2015) and JBI (Aromataris & Munn, 2020) guidelines. We included production studies of a quantitative nature that analysed the pitch patterns of the vocalisations of healthy infants aged 0 – 3 months that were monolingually exposed to any given language. The databases PubMed, Scopus, Web of Science, PsycINFO, and Linguistics and Language Behaviour Abstracts were searched for studies published from any date up and till August 2023. Additional search strategies included reference list searches, grey literature searches, and contacting active researchers in the defined research field. Studies were screened for inclusion in two phases (title and abstract, followed by full text screening). This step was done independently by two researchers with an interrater agreement of 88% for both phases. Data extraction is currently underway and done manually via a self-compiled data

extraction tool (derived from Gabrieli et al., 2019 and Tufanaru et al., 2020). This phase will be completed in December 2023. In the coming months, extracted data will be critically appraised and synthesized.

Results: We included 23 studies focusing on cry (n=15), non-cry (5) and all vocalisation types (n=3) in 11 different languages (see figure 1 for a PRISMA flow diagram of the search and screen results). Subsequently, a narrative synthesis will be conducted. The analysis will be data-driven, although adherent to the review objectives. Cross-linguistic comparisons will be made amongst vocalisation type groups namely; cry, non-cry, and all vocalisations. An early analytical remark is that significant variation exists with regards to the study characteristics of available studies. For example, the environment in which data was collected, the methodologies used to analyze pitch patterns, and the terminology used to describe the research. The review hopes to contribute to our understanding of the earliest phases of language acquisition. Furthermore, it may highlight the importance of the prenatal period for language acquisition thereby advocating for early intervention in populations with suboptimal prenatal development.

Pre-registered protocol available at: https://doi.org/10.17605/OSF.IO/XKWYR

P1-E-88 - From proximal to distal communication: Unraveling the development of gestures in Early-Years Schools

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Details

Most research on gesture development has been primarily focused on home environments, leaving a gap in understanding early communicative development in other relevant contexts of interactions, such as early-year schools (Guevara et al. 2020). These settings, rich in varied educative situations and communicative partners, offer a distinct contrast to parent-child interactions and might be pivotal for studying early gesture development.

Previous research has shown that ostensive gestures of showing and giving are the first gestures in children's communicative repertoire (Bates et al., 1975; Boundy et al. 2018); however, little is known about their origin and development in everyday interactions with others and objects, especially in early-years-schools. Recent research has highlighted the importance of ostensive gestures as a window to understanding how intentional communication is built (Carpendale et al. 2021; Salter & Carpenter, 2022), setting the foundations for more complex signs, such as pointing gestures (Cameron-Faulkner et al. 2015; Choi et al. 2021).

Our study aimed to describe the development of gestures in the infant classrooms of three early-year schools in Spain, with a specific focus on ostensive gestures – their development, communicative functions, and relation to the subsequent emergence of pointing gestures.

We conducted a longitudinal, descriptive, and observational study, analyzing the gestures of 21 children during their everyday activities in the classrooms (Guevara et al., *sent*). The children's age was between

4 and 8 months old at the beginning of the study. Observations were conducted monthly over seven months, capturing children's interactions during teacher-planned activities. We coded and microgenetically analyzed the types and functions of the gestures that children produced in their daily activities.

Our results highlight a significant increase and diversification of gesture types and functions with age. Ostensive gestures were the most frequent in the classroom. Notably, 91% of the children used ostensive gestures by 12 months, compared to only 41% for pointing gestures. Ostensive gestures had a mean onset age of 9.7 months (SD = 1.42), significantly earlier than the onset of pointing gestures (X = 11 months; SD = 1.16; Z = 2.7; $p < .05$). Despite individual variances in developmental trajectories, 86% of children initially produced ostensive gestures, and none commenced pointing before producing these gestures. Moreover, a positive correlation emerged between the frequency of ostensive and pointing gestures (Spearman's $\rho = .664$; $p < .05$).

In addition, we conducted a qualitative analysis of children's interactions involving ostensive gestures in the classrooms. We provided paradigmatic examples of the progressive construction of ostensive gestures towards more spontaneous, complex, flexible, persistent, and conventional ways of communicating with teachers and peers.

These results underscore the foundational role of proximal gestures, like ostensive gestures, in the communicative development of children in early-year school settings. They are most frequently observed in early communication and are also likely to pave the way for more complex signs, such as pointing gestures. This study contributes to the broader understanding of early communicative development and has potential implications for educational practices and future research in early childhood education.

P1-E-89 - How does children's memory affect their early word learning?

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Details

Learning words is a key part of development, and likely makes use of general cognitive abilities alongside specific word learning mechanisms. Across two studies, we examined how children's memory influences their learning of novel verbs and nouns. In Study 1, we asked whether children can ignore context when learning nouns and verbs, and in Study 2, we asked how well children remember actors and actions from events while hearing verbs.

Study 1 investigates whether the context in which a word is heard affects learning of nouns or verbs. Specific words are often heard in specific contexts (Custode & Tamis-LeMonda, 2020), but attending to and encoding extraneous context cues could be distracting. Two- (n= 47; Xage= 2;7), 3- (n= 39, Xage= 3;8) and 4-year-olds (n= 54, Xage= 4;9) heard four novel words, either nouns or verbs, while seeing an agent perform a novel action with a novel object. In the *same context condition*, children saw learning and test trials presented in a kitchen or park; *different context condition*, learning trials were

shown in one context and tested in another (see Fig. 1). During each scene, children heard "Look! She's zuving it!" (verb) or "Look! She has the zuv!" (noun). At test, they saw same action+new object vs. different action+same object. Results of an ANOVA (Age, Word and Context as BS factors; dv= mean proportion correct) indicated an Age x Word interaction, *p*=.010. Post-hoc t-tests with Sidak corrections showed that children in all three age groups learned nouns across contexts, but only 4-year-olds learnt verbs, *p*s< .02. There was no main effect of context nor interaction with context, indicating that children ignore context during word learning.

In Study 2, to better understand children's memory for events during verb learning, we adapted an adult procedure (Earles, Kersten et al.,2008) to examine children's memory for agents and actions. Three-year-olds (n=18; Xage=42m) and four-year-olds (n=19; Xage=54m) were shown 2 events and tested on their memory for them in 5 test trials: new agent (new agent, old action), new action (old agent, new action), old (same agent, same action), conjunction (old agent, old action, new combination), and all new (new agent, new action). A repeated measures ANOVA with test trial (WS) and age (BS), dv= mean 'yes' responses, showed a main effect of test trial, p<.001. Post hoc tests with Sidak corrections showed children correctly said 'yes' they had seen that person doing that action in the old trial more often than any other trial (ps<.02), and false alarmed more in the two trials with old actions (conjunction and new agent) (ps< .05) than in the trials with new actions. As children falsely remembered old actions more than new actions, this suggests they were treating the action as more important than the agent, as appropriate in verb learning.

In sum, children ignored irrelevant context information, and focused on relevant objects and actions, as they learned words. These findings offer insight into how cognitive and language processes may interact in development.

P1-E-90 - Identifying barriers to hispanic children's access to early language intervention

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Details

The benefits of early identification and intervention of language disorders are robust, ranging from reduced need for special education services in school (US Department of Education, 2010) to increased parental self-efficacy (Hughes-Scholes et al., 2019; Keen et al., 2010). Earlier intervention results in better communication and learning outcomes (Guralnick, 2011) and early screenings are a critical first step towards intervention. Children from low SES backgrounds and those from non-English speaking homes are underrepresented in early intervention in the United States (Morgan et al., 2012), highlighting the need to investigate the screening-to-diagnosis channel for at-risk communities. Previous literature on this topic (Barfield et al., 2007; Chan et al., 2022; Jimenez et al., 2014) omits parent input and fails to differentiate parents who plan to pursue an evaluation from those who do not. This information is critical for creating and implementing programs that support families who desire an evaluation but may experience barriers to getting one, thus restricting children from getting the

intervention they may need. The purpose of this study is: (1) to identify the patterns of clinical follow-up exhibited by Spanish-speaking families in the United States whose children's performance on the communication portion of a common developmental screener (ASQ-3 Spanish) was of concern, and (2) identify what factors influenced these patterns. We followed 71 children ages 5 to 36 months (M = 23.61, SD = 6.95) from primarily Spanish-speaking homes (51% of mothers with a high school degree or less) in the Dallas-Fort Worth metroplex who, based on the ASQ screener, were given recommendations for referral due to communication concerns. One month after the referral recommendation, families were contacted to determine the status of the referral (e.g., child receiving services, child does not qualify for services, etc.). Of participants contacted, 52% pursued an evaluation within one month of the recommendation, 13% had not initiated an evaluation but reported they planned to, and 35% opted not to pursue the referral. To identify factors which may have increased or decreased a family's decision to pursue an evaluation, we performed a logistic regression to obtain unadjusted odds ratios (OR) with 95% confidence intervals (CIs). We included the child's age (in months), maternal education, and private health insurance access as independent variables in the model. The logistic regression was statistically significant, $x^2(3) = 8.383$, $p = .039$ and explained 21% (Nagelkerke R^2) of the variance of pursuing an evaluation. Only one of the three variables (child's age) was found to be significant (OR .898, 95% CI, .807-.998, $p = .043$). Specifically, parents of younger children were more likely to pursue an evaluation. We hypothesize that this could be due to more pronounced deficits in the younger group, or a belief that the older children will be provided intervention in school when they enroll, or, likely a mix of both. Additional information is needed to more fully understand the factors involved in deciding to pursue early intervention services for communication concerns.

P1-E-91 - Continuity and stability of maternal mind-mindedness across different ages and contexts

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Details

Method. Participants were 17 children (n = 9 females; M_{age} = 16.00, SD = 0.32) and their mothers (M_{age} = 36.46, SD = 2.15). No child had sensory, intellectual, or speech deficits. Interactional MM was measured in terms of AMRC and NAMRC (Cohen's κ scores for AMRC and NAMRC ranged from .80 to .88). For the purposes of statistical analyses, the raw numbers of AMRC and NAMRC were transformed into percentages, by dividing them by the total number of utterances produced by mothers and multiplying by 100 (Meins et al., 2012, 2013).
Results. A 2 (Age: 16 vs. 20 months) × 2 (Context: mealtime vs. play) completely repeated ANOVA found a significant main effect of Age [$F(1, 16) = 31.77$, $p < .001$, $\eta_p^2 = .66$], indicating that mothers produced a lower amount of AMRC at 20 (M = 5.98%) than at 16 (M = 10.49%) months, and a significant two-way interaction [$F(1, 16) = 5.76$, $p = .029$, $\eta_p^2 = .27$]. A follow-up analysis of simple effects indicated that the age-related decrease in the production of AMRC was significant in the play context [$F(1, 16) = 39.13$, $p < .001$, $\eta_p^2 = .71$], but not in the mealtime context; in addition, the AMRC percentages were higher in the mealtime than in the play context at 20 months [$F(1, 16) = 7.96$, $p = .012$, $\eta_p^2 = .33$], while no differences were observed at 16 months. For the production of NAMRC, the ANOVA showed a significant main effect of Context [$F(1, 16) = 4.97$, $p = .040$, $\eta_p^2 = .24$], with the NAMRC percentages being higher in the

play (*M* = 0.45%) than in the mealtime (*M* = 0.00%) context. Regarding temporal and contextual stability, no significant associations were observed in the production of AMRC across different ages and contexts. For NAMRC, only temporal stability in the play context could be assessed, which was non-significant. *Conclusion*. The present study reached two conclusions: a) the production of AMRC decreases from 16 to 20 months; and b) MM appears to be temporally and contextually unstable. Taken together, our results converge in showing that MM should be regarded as a relational construct that varies according to several factors (e.g., contexts and ages).

P1-E-93 - Abstract generalization of phrase-structure-like patterns

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Details

Previous research (e.g., Marcus et al., 1999; Gerken, 2006) showed that 7-9-months-olds can learn algebraic-like rules (e.g., ABA, ABB) from nonsense syllables and generalize them to novel exemplars. Infants can also generalize language-like rules from sentences in a foreign language that exhibited word-order switches (i.e., ABC to ACB or to BAC) (Koulaguina & Shi, 2019). In these studies, although speech stimuli were used, the rules were not uniquely linguistic; they could have evoked cognitive-general non-linguistic processes. In this study we inquire whether typical linguistic rules evoke special learning mechanisms.

Using an artificial paradigm, we created rules each consisting of an open-class category (X or Y) combined with a closed-class (functor-like) category (a or b), resembling the typical phrase structure of natural languages. Such rules were tested in Gomez and Lakusta (2004): English-learning one-year-olds generalized aX and bY rules. Since these rules matched the head-initial structure of English (e.g., determiner+noun), infants' prior experience with English likely assisted their performance. Here we asked whether infants from a head-initial language (French) can learn head-final phrase-structure rules. In Experiment 1, 14-to-20-month-olds were trained with 16 disyllabic words (X) and 16 monosyllabic words (Y) co-occurring with 4 closed-class words (a: *alt*, *ush*; b: *ong*, *erd*). One group heard the rules Xa and Yb (e.g., *coomo alt, coomo ush; glim ong, glim erd*) and another group heard the rules Xb and Ya (e.g., *coomo ong, coomo erd; glim alt, glim ush*). They were then tested with new X and Y words co-occurring with the trained a and b words in two trial types: congruent versus incongruent with the trained rules (e.g., for the Xa/Yb group, congruent: *wazil alt; flom ong*, VERSUS incongruent: *wazil ong*; *flom alt*, and vice versa for the other group). Results show that infants discriminated the congruent and incongruent trials $t(34)=2.204$, $p<.05$, indicating that they generalized the rules.

Subsequently, we investigated whether cognitive-general learning is equally successful for the same rules. Previous work (Marcus, Fernandes & Johnson, 2007) showed that 7-month-olds have difficulty learning algebraic rules with non-speech sound. As this could be due to babies' lack of experience with such stimuli, we tested older infants who should have had more experience with non-speech sounds in life. In Experiment 2, French-learning 30-month-olds were trained with the same Xa and Yb rules, which were constructed with harmonic instruments (e.g., piano) for 16 two-note X items and 16 one-note Y items and 4 non-harmonic instruments (e.g., percussion) for the a/b items. As in the first experiment,

infants were tested with new harmonic X/Y items combined with the trained a/b items in congruent and incongruent trials. Results showed that infants failed to discriminate the test trials ($t(26)=0.739$, $p=.467$), i.e., no evidence of rule learning.

Taken together, speech seems special, not only due to infants' considerable experience with it in life, but also due to its inherent structural properties. Speech that manifests the typical phrase structure of natural languages, even when the specific pattern is absent in the child's native language, is favorable for abstract rule generalization.

P1-E-94 - More than just ping-pong: Characterizing turn-taking in parent-infant speech

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Details

Turn taking is a well-known correlate of early language development (Hillbrink et al., 2015). However, a parent-child interaction may be made up of different conversational microstructures: sometimes, speakers will coordinate an interactive sequence of turns, but sometimes, one person will hold the floor for some time. We propose a novel characterisation of conversations suitable for analysing parent-child speech, where different developmental trajectories may be observed for different features.

We identify two types of interactional sequences: volleys, where back-and-forth floor transfers occur, and monologues, where one speaker talks without ceding the floor. "Turns" involve turnover of the floor, whereas "unturns" do not (e.g., failed turn attempts, babbling, backchanneling). Depending on the nature of the communicative activity (e.g., storytelling versus collaborative play), the proportions and rates of these features may differ.

Methods: In a micro-longitudinal study in Singapore (Woon et al., 2021), parents shared an on-screen wordless picturebook (Styles, 2021) with their children (dyads N = 146), over three timepoints. In an exploratory analysis of the first timepoint, using a custom script, potential turn-taking sequences were identified from time-stamped transcriptions, using a turnover threshold of 1,500ms for Maximum Gap and Overlap. We compute total duration of narration, volley-to-monologue ratio, turn rates (volleys), and unturn rates (monologues and volleys), with rates computed over narration duration to control for interaction length. We investigate how these metrics differ with age in the large cross-sectional sample (Age: Median=1;6, Range = 0;8 – 3;4).

Results: Parental narrations were longer for older children (Duration: Median = 0:06:34; Range = 0:02:42 – 0:31:42; $\rho(144) = 0.31$, $p < .0001$). Parents differed greatly in their monologue-to-volley ratio, with a higher proportion of volleys in narrations for older children (Median: 36%, Range = 0% – 95.8%, $\rho = 0.6$, $p < .00001$). In volleys, both adult and child turn rates increase with child age (Adult: Median = 17.87, Range = 0 – 71.94, $\rho = 0.6$, $p < .00001$; Child: Median = 8.79, Range = 0 – 35.98, $\rho = 0.61$, $p < .00001$), adult unturn rates remain stable, while child unturn rates increase with age (Adult: Median = 0.30, Range = 0 – 4.80, $\rho(144) = 0.14$, $p = .09$; Child: Median = 0.34, Range = 0 – 4.32, $\rho(144) = 0.24$, $p < .01$). During adult monologues, child unturn rates decrease with age (Median = 0.53, Range = 0 – 3.85, $\rho(144)$

= -0.28, $p < 0.001$).

These findings show detailed changes in children's ability to coordinate speech from infancy into early childhood, with increasing speech activity in the interactive parts of a narration (more turns and unturns), and decreasing speech activity in the 'listening' parts of a narration (fewer unturns). This change is complemented by changes in parental speech, whereby narratives for older children include more interactivity (more turns; greater proportion of volleys). Traditional models of turn-taking may obscure some of these relationships. This novel approach of separating parent-child speech into different interaction sequence types (volleys, monologues) and individual utterance types (turns, unturns) provides nuanced insights into speech coordination between parents and children of different ages.

P1-E-95 - Exploring bilingual Latine parents' perspectives on language, parenting, and culture

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Details

As the Latine population within the United States expands, it is increasingly important not only to gain greater knowledge of children's language acquisition in Spanish-speaking and Spanish-English bilingual families, but also to explore the parental views and experiences that might affect the language learning environment (including views on language development and bilingualism, parenting strategies, cultural perspectives, and sources of adversity). In particular, it will be valuable to identify cultural and familial strengths that might help to promote successful bilingual language development.

To gain insight into the perspectives, values and experiences that might influence Latine families' language-related practices, structured interviews were conducted with Spanish-speaking and Spanish-English bilingual parents of children 0 to 3 years old. To achieve diversity in socioeconomic status and cultural variables, participants were recruited from a university participant database as well as from organizations serving Spanish-speaking families. Interviews were conducted over Zoom in the language(s) of the parent's choosing; all interviewers were fluent Spanish-English bilinguals. The interview was conducted using an open-ended survey that contains general questions about the child's typical day; who the child interacts with and talks to; childrearing strategies; the parent's views on language learning; views and practices related to bilingual language learning; views and practices related to book-reading, narrative and play; cultural values and practices; and goals, resources and challenges. Interviews were transcribed using speech-recognition transcription software, then verified by bilingual research assistants; interviews conducted in Spanish were transcribed into English by a fluent Spanish-English bilingual (though the original Spanish transcripts were referenced during coding).

Interviews were analyzed based on the thematic analysis approach described by Braun and Clarke (2006). In that approach, a set of codes are developed based on thorough review of the data set, and the coded data are then sorted into themes. Due to the structured interview format of our study, many codes and themes are defined in relation to specific interview questions or related sets of questions, though some extend more broadly. For example, in the questions on children's bilingualism, parents

frequently discussed the importance of maintaining Spanish for family ties, and the importance of learning English for school; the importance of exposure to language was described both in relation to bilingualism, and in relation to language development more broadly. In addition to providing insights into values and strategies related to language learning, our analyses are elucidating parents' perspectives on culture and the challenges facing their families. With regard to questions on cultural identity, distinctive responses emerged, with some parents describing pressure to adopt United States culture and/or difficulties maintaining their Hispanic or Indigenous culture given the dominance of the United States culture, whereas others embraced their two cultures, viewing having two cultures as an advantage. In response to questions regarding challenges, a number of parents described Covid-related socialization issues, though a broad range of other challenges also were discussed. The presentation will discuss the general themes that have emerged from the interviews in relation to possible implications for parents' language-related behaviors.

P1-E-96 - Math actions of mothers and infants in Chile during three-bag task activities

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Details

Early math skills serve as robust predictors of future academic achievement (Clements et al., 2013; Duncan et al., 2007). Extensive research has underscored the pivotal role of the home environment in shaping the development of mathematical knowledge and skills (Ellis et al., 2023; Lombardi et al., 2021). Caregivers play an essential role by fostering mathematical understanding through the quantity and nature of math talk during everyday interactions (Dearing et al., 2022; Susperreguy & Davis-Kean, 2016). Nevertheless, prevailing accounts have not explored the role of math actions, particularly during infancy. This study addresses a gap in the literature by exploring the correlation of math actions produced by infants and caregivers throughout the development of the 'Three Bags Task' activities.

A total of 675 dyads (n=675), each consisting of an infant (M=13,3 months old) and their female caregiver (M=29,9 years old) participated in a longitudinal study in Chile ("The First 1,000 days"). In the first wave of this study, each dyad completed a 10-minute video-recorded interaction of an adapted version of the Three Bags Task (NICHD-SECCYD). Caregivers' and infants' math talk was transcribed using the CLAN software, while the math actions of the mother and child were manually coded by three coders and one master coder. The inter-reliability of both transcription and coding processes was assessed using 20% of the sample, resulting in an intraclass correlation coefficient of .982 for transcription and .903 for coding math actions.

We found significant variations, both among dyads and between mothers and infants, in the frequency and types of math actions. Specifically, our preliminary analysis from a sub-sample of 123 dyads indicates that infants demonstrated significantly fewer math actions (M=5.47) than their mothers (M=27.29). The most prevalent math actions for both groups were classification and spatial reasoning. Mother's math actions predominantly centred around providing locations and directions (see Table 1).

We also found that math actions from mother and child were positively associated (r=.348). Similarly, math actions performed by the mothers were associated with their maternal cognitive stimulation score from the HOME instrument. Table 2 shows the correlation between math actions and cognitive stimulation.
Importantly, our analysis uncovers that, as early as one year of age, infants demonstrated object classification during interactions with their mothers. Regardless of their level of education, caregivers provided opportunities for early mathematical engagement through various actions.

The analysis of the remaining dyads will be added in the final version of this research, including how these math actions are linked to the math talk used in interactions.

Considering the linguistic development of infants, it is essential to acknowledge babbling as a component of their speech and determine when to code it as math talk. Expanding on Goldin-Meadow's (2023) research, math actions exhibited by infants represent a transitional stage in the acquisition of more advanced mathematical knowledge and skills.

P1-E-97 - Turning to technology: A remote language screener for young children

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Details

Language development is crucial to young children's academic achievement across the curriculum (e.g., Dickinson & Tabors, 2001; Golinkoff & Hirsh-Pasek, 1999). It is well-established that children at risk for language delay must be assessed and identified as early as possible to prevent, mitigate, or remediate potential adverse outcomes. As language is foundational to all areas of human development, the early identification of children at risk for language delays can potentially alter their academic, social, and health outcomes.

The Quick Interactive Language Screener (QUILS) assesses language in 3- to 6-year-old children (Golinkoff et al., 2017), and can easily be given by teachers, paraprofessionals, pediatricians, speech-language pathologists, interventionists, and researchers. Although the QUILS is a web-based screening tool, it was designed and normed to be administered individually in-person with the administrator and child in the same room. The COVID-19 pandemic highlighted the need for assessments that can be conducted *remotely*, enabling children to complete them from the comfort and safety of their own homes. It is unknown whether the QUILS is administered remotely is as reliable and valid as in-person administration. This project evaluates the effectiveness of the QUILS as a tool for remote assessment.

This study aims to 1) evaluate the reliability of the QUILS between two modes of administration (remote by Zoom and in-person); and 2) assess the convergent validity of the QUILS with another test, the

Peabody Picture Vocabulary Test–Fifth edition (PPVT-5), a reliable assessment for measuring children's receptive language skills (Pace et al., 2018).

Twenty-nine (16 girls) children have participated both in-person and remotely in this two-session study (Visit 1: M_{age} = 56.67, *SD* = 10.55, *Range* = 36.67-71.57; Visit 2: M_{age} = 58.92, *SD* = 10.56, *Range* = 37.56-72.80). Sessions took place 4 to 5 weeks apart (*M* = 1.31, *SD* = .83, *Range* = .80-4.43) either first in-person at the lab (*n* = 20) or remotely through Zoom from their homes (*n* = 9). Two independent sample *t*-test with a Bonferroni adjusted alpha level of .025 per test revealed no significant difference in children's performance on the QUILS whether they were tested in-person or remotely either during the first (*p* = .117) or second session (*p* = .781).

Pearson correlation analysis revealed a strong relation between in-person and remote performance on the QUILS (*r* = .732, *p* <.001). Remote QUILS was significantly correlated to performance on the PPVT-5 (*r* = .543, *p* = .003). Just as Pace and colleagues (2018) found that in-person administration of the QUILS is related to performance on the PPVT-4, these findings suggest that remote administration of the QUILS is a reliable route for measuring children's language skills. Assuming these extremely promising findings continue, the QUILS can be administered remotely, making it easier for children who cannot readily travel to be seen for language screening. The QUILS not only provides a window into children's language status, but also an early warning system for children to be assessed further by a speech-language pathologist.

P1-E-98 - Improving Early Childhood Care centers' quality to tackle language development inequalities

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Details

Around 34% of European children under 3 attend an Early Childhood Education Care setting (ECEC). But despite well-recognized impacts of the sociolinguistic environment on children's language development, the quality of care, notably regarding the educator-child interactions, is still highly heterogeneous (Eurydice, 2019).

Parental trainings on evidence-based practices to foster language development (such as the fostering of face-to-face interaction and contingency, shared book-reading, etc.) have shown promising results. We here developed a RCT protocol to measure the effect of such a training on toddlers' language development when provided to daycare center educators. Through this protocole, we aimed to answer common limitations regarding scalability, generalizability and the age of children targeted, through the reliance on ECEC professionals and an online community training system, as well as provide one of the first adaptations of RCT language interventions to the French context.

35 French daycares were recruited and randomly assigned to the Treatment or Control group, with a total of 179 educators and 230 20-28 month-olds participating (coming from diverse socioeconomic and linguistic backgrounds). The Treatment group educators followed a training on language development

combining theoretical and practical knowledge, the Control group educators followed a theoretical training on non-linguistic early cognitive abilities.

To evaluate the evolution of 1) educators' knowledge and 2) children's language development, we assessed both Pre and Post-training:

1) educators'

- general knowledge of language development through the SPEAK survey (Suskind et al., 2018);
- scores to our two quizzes specifically created to address contents broached in the two trainings.

2) children's French competency, through two novel tools developed for the need of this study (quick, reliable, adapted in age and to wide outside-the-lab testing):

- An indirect measure of productive vocabulary, through an online parental survey (a French adaptation of the computerized adaptive test version of the MBCDI using item-response theory; Kachergis et al., 2022).
- A direct measure of receptive vocabulary and word-learning abilities, through a tablet-based test

We first report effects on educators. Pre-training, we observed a significant positive main effect of their education level on scores to the SPEAK survey ($p < .001$), demonstrating heterogeneity and room for improvement despite the overall easiness of the survey. Regarding training effects, scores to the two quizzes on Treatment and Control contents at Post-test showed a significant main effect of training group, demonstrating the capacity of educators to learn from our trainings ($p < .001$; Figure 2).

As to effects on children, neither our direct tablet test of children's receptive vocabulary and word-learning abilities, nor the indirect parental vocabulary questionnaire (MBCDI) showed any effect of educators' training on children's language development at Post-test.

The implementation difficulties faced by educators throughout the project, related to ECEC's difficult daily realities (like chronic understaffing) might have contributed to these findings.

Our work shows a path forward in developing scalable universal language interventions by partnering with community actors. It raises questions regarding the feasibility of fostering child development through daycares without meaningful investments to improve the entire ECEC system.

P1-E-99 - ICIS 2024 Duet 2.0—Preliminary findings of a telehealth, early language intervention for English and Spanish-Speaking families experiencing economic adversity

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Details

Introduction: Family-centered, early intervention is a scalable, efficacious tool to boost interaction quality and improve health outcomes for children with or at risk for language delay. However, families' individual strengths and needs vary, resulting in inequitable early language intervention access and effectiveness (Roberts et al., 2019). Low-household income is not an individual clinical indicator of language delay. However, as a group, children under 5 whose families experience economic adversity are at increased risk for language delay. Children from marginalized racial, ethnic, and cultural groups are disproportionately affected by economic adversity and underserved by early interventions (Manz et al., 2010). Nearly 19% of children under 5 in the US—14% of White, 35% of Black, and 25% of Hispanic or Latine children—live in households with income below 100% of the Federal Poverty Level (U.S. Census Bureau, 2021). Family-centered, culturally responsive, language intervention can improve health equity for children experiencing economic adversity.

Hypotheses: We hypothesize that caregiver developmental knowledge and self-efficacy perceptions will be positively associated with baseline dyadic interaction quality (i.e., conversational turns) and child language (i.e., vocabulary). Furthermore, we hypothesize that dyads who receive Duet 2.0 will make greater interaction quality and child language gains than those in the comparison group. Finally, we hypothesize that caregiver developmental knowledge and self-efficacy perceptions will moderate intervention gains. Specifically, we predict that caregivers with high self-efficacy and developmental knowledge at baseline will make the greatest intervention gains.

Study Population: We will analyze data from our ongoing Duet 2.0 clinical trial (NCT04692519). Importantly, we have finished participant enrollment (n=40 dyads enrolled and assigned) and anticipate completing follow-up data collection by Spring 2024. Participants include English- and Spanish-speaking families with children 18-30 months at enrollment with household income below 200% of the Federal Poverty Level.

Methods: We used a stratified (by language group), blocked, randomization, to assign eligible dyads to the Duet 2.0 or delayed-access comparison group. Participants in the Duet 2.0 group received 7 remote coaching sessions focused on knowledge of child development, creating opportunities for communication in everyday life, back-and-forth conversational duets, and scaffolding. Intervention was provided via video modules, supported by a trained coach, in the participant's dominant language (English or Spanish). We collect caregiver (i.e., self-efficacy and developmental knowledge), child (i.e., language skills), and dyadic (i.e., conversational turns) measures at baseline, immediate post-intervention, and 3-months post intervention. We transcribe interaction samples from caregiver–child dyads during book-sharing, free play, and a daily life activity to calculate conversational turn rate. We measure caregiver developmental knowledge using the SPEAK-II (Suskind et al., 2018) and self-efficacy perceptions using the Self-Efficacy for Parenting Tasks Index-Toddler Scale (Coleman & Karraker, 2003). We assess child language using the MacArthur-Bates Communication Development Inventories (Fenson et al., 2007).

Results: Transcription and coding to examine our primary outcome measure, conversational turns, is ongoing and will be completed prior to the presentation. Our preliminary self-efficacy and developmental knowledge outcome data are promising. The outcomes described are part of our pre-specified analysis plan in the clinical trials registry.

P1-F-100 - Neural functional connectivity from 10 to 12 months: Using EEG coherence to examine task attention

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Details

Resting state networks including the default mode network (DMN) and frontoparietal network (FPN) have been found in infants as young as 2 weeks old and continue to develop throughout childhood and adolescence (Xu et al., 2017). The DMN involves multiple prefrontal and parietal areas and is thought to be more active during states of wakeful rest. The FPN is upregulated during the top-down modulation of attention required for cognitive tasks. In general, when DMN activity is low the FPN is high and vice versa (Fox et al., 2005). Both the DMN and FPN reliably strengthen during the first year of life (Gilmer et al., 2018). DMN hyperconnectivity is linked to attentional deficits and behavioral dysregulation in multiple age groups (Mohan et al., 2016). DMN and FPN are traditionally examined using fMRI which significantly limits research on awake infants. We used EEG coherence along DMN and FPN regions to track the development of the networks from 10 to 12 months of age. Network coherence was compared to concurrent infant attentiveness. We anticipated attention group differences in network development.

Forty-seven typically developing infants (24 girls) were seen monthly in the research lab from 10 to 12 months. During the monthly visits, EEG was recorded during a task that required the infants to focus and sustain attention on a series of small toys being presented to them one by one by an experimenter. The sustained attention of the infants was later scored behaviorally according to the infants' voluntary focus on the toy versus needing to be redirected to the toy. Infants were divided into a higher attention group and a lower attention group. We hypothesized that infants who as a group across age voluntarily looked at and attended to the toy would have increased FPN (F3P3 coherence) and decreased DMN (Fp1P7 coherence) compared to infants whose attention had to be redirected towards the toy. DMN is thought to be left hemisphere dominant in adults (Rojas et al., 2018).

Repeated measures MANOVA showed a three-way interaction between attention group, network, and age (Hotelling's=0.330, p=0.003). As shown in Figure 1, as expected, DMN coherence was lower than FPN coherence at each age indicating infants' focus on the toys. Additionally, the high and low attention groups were statistically different in the FPN at all ages (p=0.05, <0.0001, <0.0001 respectively), with the lower attention group having a higher FPN, typically indicative of higher attentiveness, which does not map onto the behavioral coding for this group. There was a trend of increased DMN coherence in the low attention group at 12 months (p=0.11) indicating less neurophysiological attentiveness which maps onto the behavioral coding for this group.

We anticipated that the infants displaying more attention to the task would have higher FPN and lower DMN activity. This was only seen in the DMN at 12 months, and the opposite was seen in the FPN at all three months. Previous DMN and FPN work with infants has utilized nonsocial tasks (Kelsey et al., 2021); it may be that our use of a social attentional task influenced our results.

P1-F-101 - Individual differences in reward sensitivity shape infants' attention biases towards caregiver faces

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Details

Although caregivers are socially rewarding (Minagawa-Kawai et al., 2009), they are one of many stimuli that compete for infants' attention. As a result, infants rely on attention skills to identify relevant stimuli in their environment. Attention orienting supports selection of relevant information amongst competing stimuli, and attention holding maintains attention on the selected stimulus for detailed processing (Cohen, 1972). Infants preferentially look (i.e., show biased attention holding) to caregivers (e.g., Barrera & Maurer, 1981), but whether they are similarly biased to orient to caregiver faces is unknown. Furthermore, the extent to which these early attention biases reflect caregiver social reward value (i.e., motivated attention mechanisms; Anderson et al., 2016) remains unclear. Individual differences in Surgency, an index of reward sensitivity (Vervoort et al., 2015), relate to face recognition in infancy (Rennels et al., 2020), providing initial evidence that reward sensitivity may broadly shape infants' attention to faces. However, it is unknown whether infants' reward sensitivity relates to early attention biases to caregivers specifically.

To address these questions, we recorded eye movements from 3.5- to 10.5-month-old infants (N = 64) as they viewed caregiver and stranger faces appearing in multi-item arrays (Fig. 1). The task included trials in which either the caregiver or stranger face appeared among multiple distractors and trials in which both faces appeared in the array simultaneously. By presenting faces in direct competition, these latter trials increased selective attention demands and more closely resembled prior studies that observed attention holding biases to caregivers in infancy. All arrays remained visible for 4 s, and infants completed six trials in each condition (total 18 trials). We assessed individual differences in Surgency, an index of reward sensitivity, using the *IBQ-R* (Gartstein & Rothbart, 2003). We measured attention orienting via the proportion of trials in which infants' first look was directed at a face and attention holding via their total duration of looking to each face. We then computed attention bias difference scores for each measure (i.e., looking to caregiver - looking to stranger).

At the group level, infants showed no overall attention orienting or holding bias to caregivers (*p's* > .4). However, individual differences in reward sensitivity related to infants' attention biases to caregivers. Infants with higher Surgency scores showed overall more robust attention orienting ($p = .08$) and holding biases to caregivers ($p = .002$). These effects also varied across trial types. Specifically, we observed the relation between Surgency and increased orienting to caregivers only during trials where both faces appeared simultaneously ($r(64) = .35$, $p = .006$; Figure 2A). In contrast, we observed a relation between Surgency and preferential looking to caregivers only when one face appeared in the array ($r(64) = .42$, $p = .001$; Figure 2B). Overall, these results suggest that, over the first year, infants show parallel attention orienting and holding biases to caregivers that vary based on task selective attention demands and may reflect underlying reward-based attention mechanisms.

P1-F-102 - The effects of melody and lyric familiarity on infant responsiveness to well-known music

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Details

For infants, familiar songs are particularly salient in their musical environment. Infants listen longer and spend more time moving rhythmically to familiar compared to unfamiliar songs (e.g., Kragness et al., 2022), but how they identify these songs remain unclear. Melody and lyrics likely contribute to early song recognition, since even young infants tease apart familiar compared to novel cues from both musical properties (e.g., Mehr et al., 2016; Thiessen & Saffran, 2009). Here we explore whether infants at different developmental stages consider both melody and lyrics when responding to a well-known song from their current musical repertoire.

Infants (*N* = 108) across three age groups (6-mo, 11-mo, 20-mo) participated in a preferential listening paradigm hosted by the experimenter over Zoom. Infants were presented with four song conditions: acapella recordings of the common children's song *Wheels on the Bus*, an original composition, and two additional songs mismatched in melodic and lyrical familiarity (i.e., melody from *Wheels* paired with lyrics from the novel song, and vice versa). Infants' attentive listening to each song condition was measured via looking time toward the screen across 16 trials by an experimenter live coding via webcam. Trials ended after 31 s or after 2 s of consecutively looking away. Infants' rhythmic movements and iconic gestures (i.e., movements that match the actions being described in the lyrics) were annotated offline.

Generalized linear mixed models were used to evaluate main effects and interactions between melodic familiarity, lyrical familiarity, and age on total listening time and rhythmic movement duration, with random intercepts per participant. Neither 6- nor 11-month-old infants demonstrate significant differences in attentive listening across melody and lyric familiarity conditions (*p's* > .22). The 20-month-old infants preferred novel music, listening significantly less when both melody and lyrics were familiar (i.e., *Wheels*, $p = .008$). In contrast to their attentive listening patterns, 11- and 20-month-old infants spent more time moving rhythmically to the familiarly matched *Wheels* relative to any song condition with unfamiliar melody or lyrics ($p = .01$). We also explored infants' use of iconic gestures. Older infants displayed more of these gestures than younger babies. Interestingly, over 70% of trials including an iconic gesture showed alignment between the lyrics (e.g., The wheels on the bus go round and round) and action demonstrated (e.g., rolling arm gesture). This pattern was found in both familiar and novel lyric conditions, providing suggestive and new evidence that infants may sometimes attend to semantic content in musical lyrics. Data coding of 6-month-old infants' rhythmic movements are currently underway.

Together, these results demonstrate that by their first birthday, infants integrate everyday melodies with their accompanying lyrics to recognize well-known songs. Interestingly, they seem to demonstrate this integration first through rhythmic movement, and later through selective attention to songs that have at least one unfamiliar element. Early development of everyday song recognition through musical feature identification is complex. Future directions should explore how quantity or quality of song exposure during caregiver-infant musical interactions may affect melody and lyric recognition.

P1-F-103 - Preference for the other race faces: Implications for perceptual narrowing

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Details

The other-race effect (ORE) in face recognition is described as a better and more accurate recognition memory for one's own race than for faces of another race. Several interpretations for the other-race effect have been offered. The explanation that we have greater perceptual expertise with our own-race faces is widely supported (Albrecht, Pierce, Tarry, & Tanaka, 2009; Rhodes, Brake, Taylor, & Tan, 1989; Tanaka, Heptonstall, & Hagen, 2013). Evidence is consistent with the view suggesting greater sensitivity to featural and configural differences between own - race than with other races. Evidence suggesting that early experiences, like visual, auditory, multimodal, language, and social contexts, shape one's processing of familiar and unfamiliar race classes and lead to the emergence of the ORE within the first year of life will be reviewed. The current study investigated whether exposure to other race faces from birth to four months impairs recognition of own race faces during the lockdown. Using a visual/paired comparison paradigm, we tested 4, 6, 10, and 12-month-old infants from the UAE. Arab and African faces were used. Each infant had, from birth to 12 months, at least two African caregivers. During this period, the infant was naturally exposed to the parents and the caregiver. Family visits and gatherings were not permitted by the law. The findings show that four-month-old infants were able to recognize the mother's face paired with that of a female African stranger. Infants, however, fixated longer on the African face than the family member's face. Six and ten-month-old infants showed the same preference patterns. At 12 months, infants recognized a family member face paired with an African stranger. The lockdown and people wearing masks impaired face processing development. Our data can be interpreted in terms of both perceptual learning and perceptual narrowing. The induced experience of the other-race faces did reverse the effects of perceptual narrowing on infants' visual recognition memory during infancy.

Keywords: infants, Own-race effect, the other-race effect, perceptual narrowing

P1-F-104 - Infant top-down neural representation of meter: Investigating generalizability

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Details

Just as speech sounds are temporally organized according to language-specific rhythm patterns, music is temporally organized according to an extracted beat and metrical hierarchy. Such rhythmic organization provides a structure for organizing incoming information into meaningful units, aiding in attention and learning. Previous electroencephalography studies show that infants can extract the beat and meter of auditory rhythms in a bottom-up manner, but the extent to which infants can apply metrical structures in a top-down (i.e., internally driven) way is less understood.

Recently, we provided evidence for top-down meter perception in 6-month-olds, by priming infants to hear an ambiguous 6-beat rhythm either in three 2-beat groups (duple meter) or two 3-beat groups (triple meter), by adding loudness accents on either beats 1, 3 & 5 or 1 & 4, respectively (Flaten et al., 2022). After priming, we presented the unaccented (metrically ambiguous) rhythm, to which we added occasional pitch changes on beat 4 (strong in triple meter, weak in duple) and beat 5 (strong in duple, weak in triple). To direct infant attention to the 6-beat rhythm, we paired a visual stimulus of circles that flashed in time with beat 1 only. Infants showed larger mismatch response (MMR) amplitudes to pitch changes occurring on strong compared to weak beat positions, according to their priming, though effects were stronger for duple-primed infants. MMR latencies did not differ according to priming. The extent to which the duple bias was due to the stimulus, or factors intrinsic to the listener, such as enculturation, is unclear.

The current study aimed to replicate and extend Flaten et al. by investigating, 1) whether infants can generalize a primed metrical structure across tempo variation, and 2) whether a duple bias remains with metrically unbiased stimuli. We primed 6-month-old infants (N=19 per priming group; data collection is ongoing) to hear a repeating 6-beat rhythm either in duple or triple meter while we measured EEG. Each infant heard 3 out of 4 possible priming tempos (231, 278, 400, and 480 ms IBI). Priming trials were presented at one of these tempos with loudness accents to indicate the meter, followed by 16 unaccented isochronous test trials at 333 ms IBI, including occasional pitch changes on beats 4 or 5 to elicit MMR. This pattern of priming and unaccented test trials repeated 9 times per block, with priming tempo changing each time, for 3 blocks.

Infant MMR was present in frontal sites but unlike Flaten et al. (2022), amplitudes did not differ according to priming. However, when exploring effects of musical experience, those infants who regularly attended music classes showed larger MMR in FL sites for beat 5 compared to beat 4, while those who did not attend classes showed equivalent MMR for beats 4 and 5. While the task of generalizing a primed meter in this study was too difficult for infants, these results suggest that musical experience may enhance enculturation to the duple meter. Future studies should examine tempo generalization in infancy using a simpler task.

P1-F-105 - Which of the implied and apparent motions is generalized to real motion?

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Details

We investigated whether adaptation from implied motion (IM) was transferred to real motion by using Optokinetic nystagmus (OKN) in infancy. Recent studies (Shirai & Imura, 2014, 2016) showed that viewing a still image depicting motion shifted visual preference in the same direction for 5- to 8-month-olds. Adult studies (Winawer, 2008) showed that viewing IM altered the perceived direction of subsequently presented real motion. We examined whether viewing a series of images depicting motion altered OKN to random dot Kinematogram (RDK) in infants. In Experiments 1 and 2, 40 5- to 6-month-olds and 7- to 8-month-olds participated. The RDK was presented 10 times in the pretest, following 10 trials of IM adaptation and test. In the pretest, signal dots of RDK moved to the left or right. In IM adaptation, 10 randomly selected leftward (or rightward) IM images were presented at the center of the monitor at a rate of 600 ms per image with no ISI in Experiment 1 and 300 ms ISI in Experiment 2. The directions of IM images were leftward in half of the 10 trials and rightward in the other half. In the test, RDK was presented immediately following the last IM image. Test RDK and IM images were the in same directions.An observer, who was blind to the direction of motion, judged the direction of OKN from recorded videos. We calculated the number of matches of OKN responses of each RDK direction as "match ratio of OKN." We compared "match ratio of OKN" before and after IM adaptation (as pretest and test), and conducted a two-way mixed analysis of variance (ANOVA), with age groups (5-6 months and 7-8 months) as between-participant factors and adaptation (pretest and test) as within-participant factors. In Experiment 1, we found that IM adaptation reduced the OKN response to RDK direction for 7- to 8-month-olds. Additionally, 7- to 8-month-olds could detect the IM direction as well as the RDK motion direction in the pretest. These findings suggest that only 7- to 8-month-olds' OKN response to RDK was altered by viewing a series of images depicting motion; these patterns were not found for 5- to 6-month-olds. In Experiment 2, to impair the apparent motion perception, IM images were presented with 300 ms ISI. The results were the same as in Experiment 1. This means that the results of Experiment 1 were based on IM, and not apparent motion.

P1-F-106 - The role of naps for infants' memory of information related to unexpected events

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Details

Naps play a critical role for infants' consolidation of newly learned information (cf., Seehagen et al., 2019). However, it is currently unclear whether nap-dependent consolidation occurs uniformly for all information or if it occurs selectively, such that only some types of information are strengthened during sleep (Stickgold & Walker, 2013). As events violating infants' expectations provide a special learning opportunity (Stahl & Feigenson, 2015), information presented in this context might be particularly salient and hence be selectively consolidated during a nap shortly after encoding.

In this preregistered online study, N = 34 eighteen-month-old infants watched videos of recorded events from home. Each infant witnessed one object violating their expectation regarding a physical principle (VoE; e.g., solidity of a wall; Fig. 1) and another object behaving in agreement with their knowledge (no VoE). After each event, the object was presented in front of a single-colored background, giving infants the opportunity to learn an object-color association. By scheduling participations according to infants'

natural nap times, one group had a nap after the demonstration, while the other stayed awake until night sleep.

To assess the effect of VoE-event videos on memory and learning after 24 hours, we used two different approaches. First, association memory was measured via looking times in a visual paired comparison (i.e., showing the target object and novel distractor + colored background, analogous to association learning video). Second, memory of the VoE event was assessed by measuring the duration of exploration behavior directed at the wooden 3D-version of the VoE-object (compared to the no-VoE-object and a novel distractor object). Therefore, a transfer from the 2-D video context to the 3-D real-world environment was required.

Regarding the association memory, analysis showed a significant interaction effect of sleep status (nap, no nap) and event outcome (VoE, no VoE) ($F(1,64) = 4.08$, $p = .048$, $\eta^2 = .06$). Post-hoc analyses revealed that infants in the nap-condition did not exhibit association memory in the no-VoE context ($p = 0.028$). This pattern could indicate that information presented in a knowledge-conforming context might be selectively discarded during naps (cf., Stickgold & Walker, 2013).

Regarding behavioral exploration, analysis showed that infants in both conditions (nap & no nap) selectively explored the VoE object after 24 hours (main effect of object type, $F(2,96) = 5.53$, $p = .005$, $\eta^2 = .1$). Hence, memory of the object behaving in an unexpected way, may be salient enough to undergo consolidation independent of timely sleep after encoding. Specifically, infants explored the only VoE-object proportionally longer than the distractor ($p = .018$) and longer than chance ($m = 0.38$, $t(33) = 1.924$, $p = .032$), also showing their ability to transfer information from video to the real environment of their home.

The final interpretation requires data concerning the initial encoding, learning and exploration immediately after the demonstration, which will be collected in early 2024 and presented on the poster.

P1-F-107 - Fetal visual responses to agentive motion cues

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Details

How an object moves through time and space provides invaluable visual cues to disambiguate and categorise information in the world. Humans have an intuitive ability to extract social meaning from the movement of even abstract shapes (Scholl & Tremoulet, 2000). Motion interpretation moves beyond simple perception and is a fundamental building block for social interaction (Michotte, 1963). When in development do we begin to understand animacy and social agents? Neonates can differentiate between types of motion events (causal and non-causal) and show a preference for events that demonstrate physical causality (Mascalzoni et al., 2013). Is there a prenatal predisposition to attend to motion cues that are intrinsic to the foundations of social cognition?

The current study investigates fetal sensitivity to spatio-temporal cues that correlate with adult interpretations of agentive motion. Participants included 98 singleton fetuses between 33 and 36 weeks gestation. 2D ultrasound was used to visualise the fetal lens and record fetal eye movements. A modified version of an agentive "chase" study by Rochat et al., (1997) was employed. Fetuses were presented with two separate point light displays of "agentive" and "independent" sequences, consisting of two dots (dot diode emitting at 650nm) Dot A and Dot B in motion. In the "agentive" sequence, Dot A moves in a linear trajectory at a constant speed. Dot B accelerates from a stationary position at an angle towards Dot A. Both dots finish at the same time, not touching. In the "independent" motion sequence, Dot A moves in a linear trajectory at a constant speed. Dot B moves at a faster speed in the same direction parallel to Dot A, maintaining the same distance from dot for the full motion sequence. A sample of 124 adult viewers rate the "agentive" motion sequence as more animate and more like a chase than the "independent" condition. Fetuses were presented each sequence eight times in each condition.

Eye movements were recorded in each condition to measure fetal visual engagement. We hypothesize that the human fetus will demonstrate more eye movements towards the stimuli in the "agentive" condition compared to the "independent" condition. The data has been collected and is currently undergoing coding and analysis. Full consideration of the dataset may reveal distinct trends regarding fetuses' preferences for agentive motion. Understanding visual preferences in utero informs our knowledge of perceptual processes and highlights the interplay between perception and the foundations of higher-level social-cognitive functions that may well have their origins in the prenatal period.

P1-F-108 - Infants 4 months of age respond to stereopsis based on a monocular gap

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Details

Perception of depth can be generated by presenting on eye with a solid rectangle and the other eye with two smaller rectangles separated by a vertical gap. The visual system interprets this situation as two rectangles placed at different depths and separated by a small gap. Figure 1 exemplifies the viewing geometry of this situation: our visual system explains the fact that the vertical gap and the white background visible in the gap are perceived by the right eye only, while the left eye perceives a single, complete rectangle, by a depth difference of two small rectangles. More specifically, according to this explanation, as the left rectangle is located nearer than the right rectangle, the right eye can see a part of the background through the gap. In contrast, the left eye sees only a uniform black surface, as the right tip of the left rectangle camouflages the gap.

In a natural visual preference study, it was asked whether participants 4 months of age responded to the depth effect generated by a monocular gap. Two experimental conditions were created, in one of which (2a-b condition) the monocular depth effect was twice as strong as in the other one (2a condition), according to Pianta and Gillam (2003). In both conditions, it was tested whether the stimulus bearing monocular gap stereopsis was preferred over a comparison stimulus without depth. In both conditions,

the stimulus with unpaired stereopsis not only contained a monocular gap but also horizontal outer edge disparity. In order to control for the impact of outer edge disparity, the comparison target had the same outer edge disparity as the target with unpaired stereopsis. Moreover, in both conditions, gap size in the stimulus with unpaired stereopsis was equal. However, horizontal disparity in the 2a-b stimulus was twice as large as in the 2a stimulus.

According to the results, the infants preferred looking at the stimulus with monocular stereopsis in the 2a-b, but not in the 2a condition, the condition with a smaller horizontal disparity. Moreover, the infants displayed a stronger natural preference in the (2a-b) condition displaying a relatively large depth difference than in the (2a) condition displaying a relatively small depth difference.

The differential results for the two experimental conditions substantiate that outer edge disparity contributed to the infants' looking behavior. Yet, the spontaneous preference for the 2a-b target over the comparison target found in the 2a-b condition cannot be explained solely by the horizontal disparity cue, because the amount of horizontal disparity was the same in both targets. Instead, the natural preference found in the 2a-b condition depended critically on the combination of horizontal disparity and monocular gap. It can therefore be concluded that a monocular gap was a necessary, though not sufficient, factor in directing the infants' visual attention. A monocular gap produces a natural preference only in combination with a relatively high horizontal disparity.

Overall, these findings provide evidence to suggest that infants aged 4 months are able to extract depth from monocular, vertical gap information.

P1-F-109 - Maternal multimodal responses and infant language outcomes: Relations with infant distractibility from social events

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Details

Infant attention skills are foundational for language learning. Better attentional control (e.g., lower distractibility, greater sustained attention, greater intersensory matching) predicts better language outcomes in infants and children (Edgar et al., 2022; Salley et al., 2013; Testa et al., 2023; Yu et al., 2018). Mother-infant dyadic interactions also predict infant language development. For example, greater maternal redirecting of infant bids for attention (i.e., guiding-attention to a different object/event) predicts lower levels of infant distractibility and, in turn, better infant receptive language (for mothers who are generally responsive to infant bids; Testa et al., 2023). Here we explored how the frequency of maternal multimodal (bimodal and trimodal) responses to infant bids for attention contribute to this relationship. Maternal multimodal behaviors have been shown to facilitate infant sustained attention (Suarez-Rivera et al., 2019) and, in turn, vocabulary size (Yu et al., 2018). They can also highlight the relations between objects and labels (Gogate & Bahrick, 1998). Thus, mothers' use of multimodal behaviors when interacting with their infants may increase the attentional salience of the objects to which mothers refer. This may, in turn, reduce distractibility and lead to better language outcomes. We tested this possibility by assessing relations among frequency of maternal multimodal

(bimodal and trimodal) responses, infant distractibility, and infant language outcomes (receptive and expressive vocabulary). Infants (*N*=79) participated in an ongoing longitudinal study from 3- to 72-months of age. *Distractibility*: Infant distractibility from social events at 12-months was assessed using a three-screen audio-visual protocol, the Multisensory Attention Assessment Protocol (Bahrick et al., 2018; Figure 1). *Maternal Multimodality:* Infant bids for attention and frequency of maternal responses for bids that were accepted (i.e., followed-in) and redirected were coded from an 8-minute dyadic interaction at 12-months. Maternal responses (i.e., gazing while smiling, vocalizing, touching the infant) were coded for unimodal, bimodal, and trimodal behaviors according to the number of modalities used. *Language Outcomes:* Infant receptive and expressive vocabulary were assessed by the Mullen at 18-months.

Mothers used a greater proportion of bimodal and trimodal behaviors when redirecting than accepting infant bids, *t*=2.86, *p*=.007. Correlations revealed relations between maternal trimodal (but not bimodal) responses when redirecting bids and infant distractibility, *p*=.056, and between infant distractibility and receptive (but not expressive) vocabulary, *p*<.05. To test our main research question, we used SEM to explore pathways between maternal multimodal behaviors, infant distractibility, and infant language outcomes. Results revealed that infant distractibility mediated the relation between maternal trimodal responses when redirecting bids and infant receptive language, *ps*<.05. Findings demonstrate that maternal trimodal behaviors (e.g., gazing/smiling, vocalizing, and touching the infant) when redirecting infant bids for attention predict less infant distractibility, and, in turn, better receptive language outcomes. Mothers also use a greater number of modalities when redirecting than accepting infant bids. This may increase attentional salience of the objects to which mothers refer and improve infant attentional control. This, in turn, reduces infant distractibility and leads to better language outcomes. Findings highlight the role of maternal multimodal behaviors in dyadic interactions for guiding infant attention.

P1-F-110 - Effects of mask-wearing on infant visual attention to audiovisual speech

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Details

The goal of the current study was to examine the effects of mask-wearing on infant visual attention to audiovisual speech in native and non-native languages. Infants have been shown to distribute their selective attention to regions of a speaker's face differentially based on the infant's age and language experience. For example, Lewkowicz and Hansen-Tift (2012) found that from 3 to 6 months of age, infants focus their selective attention on the eyes of a speaker prior to shifting their selective attention more toward the mouth of a speaker at 8 to 10 months of age. At around 12 months of age, infants begin to shift selective attention back to the eyes when spoken to in their native language while continuing to focus more on the mouth when spoken to in a non-native language. This focus on the mouth of a communicative partner in mid- to late-infancy is associated with later developmental

outcomes such as greater expressive language skills and word learning, and more advanced social and emotional development (Tsang et al., 2018; Pons et al., 2019), thus raising concerns regarding potential implications of widespread mask-wearing on language learning and social development in infancy. Although school age children have been found to be less accurate in determining emotions of masked compared to unmasked faces (Ruba & Pollak, 2020), the impact of masking on early language development and infant selective attention to audiovisual speech remains largely unexplored. The current project examined the immediate effects of mask-wearing on the distribution of infant selective attention to the face of an actress speaking in either a native or non-native language. Twenty-one 6-month-old infants and nineteen 12-month-old infants were shown a series of video recordings of an actress speaking in their native language (English) with and without a mask on, as well as recordings of the same actress speaking in a non-native language (German) with and without a mask on. Proportion of total looking time (PTLT) to either the eye area of interest (AOI) or the mouth AOI, and run count (a measure of scanning between AOIs) were examined to explore whether mask-wearing and language experience impacts infant selective attention to audiovisual speech. Overall, infants spent more time looking at unmasked presentations in comparison to the masked presentations, $t(37)=-3.80$, $p=<0.001$. Regardless of language or age, infants attended more to the eye region of the face in masked presentations ($t(37)=3.597$, $p=<0.001$) and more to the mouth region of the face in unmasked presentations($t(37)=-3.137$, $p=0.002$). Infants also made more runs between the eyes and the mouth in the unmasked condition than in the masked condition, $t(37)=2.572$, $p=0.007$. These results illuminate the immediate effects of mask-wearing on infant visual attention to talking faces and add to the current literature regarding patterns in infant selective visual attention in early development.

P1-F-113 - Infants' detection of briefly presented facial expressions

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Details

Emotion detection (i.e., the ability to perceive the presence of an emotion in faces or other physical mannerisms) occurs very rapidly in adults and is thought to occur outside of an one's conscious awareness. Research on the detection of emotion in infants has used event-related potentials, skin conductance responses, and pupillary responses; we sought to determine whether emotion detection could be demonstrated with behavioral measures with 7.5-month-old infants. In a backward masking preferential looking procedure, an actor's emotional expression (happiness, fear, or anger) was paired with the same actor's neutral expression. Upright and inverted emotional faces were presented for either 167, 367, 567, or 767ms followed by a scrambled backward mask displayed for 1500ms (minus the emotional stimulus duration) in Experiment 1 (N=31). We sought to determine what level of exposure was necessary for infants to detect specific emotions, as indicated by systematic differences in looking to the paired stimuli. The shortest duration (167ms) was chosen because previous research has found infants' perceptual threshold for detecting a face versus a non-face is around 150ms. Experiment 1 was conducted online and found that, across all 4 durations, there was only a marginal effect of Emotion ($F(2, 1236) = 2.40$, $p = .09$). This was due to the overall mean for Fearful being marginally different than chance (50%), $t(454) = 1.80$, $p = .07$, but the means for Angry and Happy not differing from chance. There was a significant difference between the Fearful and Angry conditions; infants

looked significantly longer to the Fearful target ($t(1235) = -2.14$, $p = .03$). There was also a significant preference to look to the left side but no other main effects or interactions. The finding of greater looking to the left was unanticipated but not without precedent in infant research (Guo, Meints, Hall, Hall, & Mills 2009).

Because the task was quite challenging for infants in the online study (durations, male and female faces, target side, and orientations alternated randomly throughout the trials), we tried to simplify the (in person) eyetracker study. Based on previous research and Experiment 1's results, it was unclear whether the 167ms duration was below infants' conscious threshold. Thus, Experiment 2 (N=27) is being conducted with upright, female faces presented at two durations in separate blocks. One duration (100ms) is subliminal (well below the predetermined 150ms threshold) and one duration is supraliminal (700ms). Preliminary results suggest that there is a main effect of Emotion ($F(2, 549) = 3.18$, $p = .04$). Fear is significantly detected (compared to 50% chance) regardless of length of the stimulus duration (M= 56.86, $t(549) = 2.11$, $p = .03$), and there is also a preference overall to look to the left. We plan on continuing the study until we have 32 infants with usable data. These studies show that under the right conditions, infants of 7-8 months exhibit behavioral evidence of detection of fearful expressions (presumably even when presented below their conscious threshold), which is line with a well-documented fear bias emerging at 7 months of age.

P1-F-114 - SES differences in early attention skills from infancy to early childhood

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Details

Children from lower SES backgrounds are at greater risk for poorer educational and health outcomes than children from higher SES backgrounds (Lee & Burkam, 2002). Disparities in outcomes between children from lower vs higher SES backgrounds become evident early in development. Children from lower SES backgrounds demonstrate poorer cognitive skills (Rose et al., 2011) and early language (Fernald et al., 2013; Hoff, 2013), with disparities widening across age (Fernald et al., 2013). SES disparities in attention skills are also evident in infancy, with infants from higher SES backgrounds showing better attention orienting (Amso et al., 2014) and greater focused attention to complex visual scenes (Clearfield & Jedd, 2012) compared to infants from lower SES backgrounds. Recent research has emphasized the importance of early *Multisensory Attention Skills* (MASks; attention maintenance, shifting/disengaging, intersensory matching) as building blocks for early learning and cognitive development (Bahrick et al., 2018). MASks predict child language skills (Edgar et al., 2022), working memory (Edgar et al. 2023), and social skills (Ramirez, in review). However, little is known about whether differences in MASks are evident in infants from higher versus lower SES backgrounds. As a first step in addressing this question, the current study investigated how attention maintenance to audiovisual events develops across the first three years of life for children from higher vs lower SES backgrounds. We predicted that children from higher SES backgrounds would show longer attention maintenance to social events compared to children from lower SES backgrounds, given the importance of attention to social information for later language and cognitive outcomes.

Children (N=96) participated in a longitudinal study from 3- to 36-months. At all ages, children received the Multisensory Attention Assessment Protocol (MAAP; Bahrick et al., 2018), a novel individual difference measure of MASks. Trials consisted of a 3s central distractor event, followed by two 12s audiovisual events (on the left and right sides of the screen), one of which was synchronous with its natural soundtrack. Attention maintenance was calculated as the proportion of total looking time to the audiovisual events divided by the trial length (12s). Maternal education was used as an index of SES: the lower SES group (n=44) had no/some college and higher SES group (n=52) had a bachelor's degree or higher.

Independent samples t-tests for each age revealed significantly greater attention maintenance in the higher than lower SES group at 3-months ($p=0.016$, $d=0.528$) and at 36-months ($p<0.001$, $d=0.876$), as well as marginal significance at 24-months ($p=0.062$, $d=0.524$; see Figure 2). There were no significant group differences at the other ages (6-, 12-, 18-months).

These findings suggest that family SES environment influences early attention skills and disparities in attention maintenance. Children from higher SES backgrounds demonstrated greater attention maintenance in early childhood, which may lead to better developmental outcomes. Research on MASks in infancy and early childhood may help identify children at risk for poorer language, cognitive, and/or social outcomes and guide interventions to attenuate the adverse effects of lower SES on child development.

P1-F-115 - Chromatic image statistics predict infants' visual engagement with picture books

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Details

Introduction: Engagement with books in early childhood is thought to be a predictor of later literacy skills (Brown et al., 2022), and several studies have investigated the features of books which affect language learning in young children (e.g., Shinskey, 2021). However, there has been little consideration of the visual factors that affect how infants engage with books. One popular idea amongst book designers is that infants respond best to high-contrast black and white books due to infants' poor vision. However, such designs may be too simplistic for older infants since infants have trichromatic colour vision by at least 2-3 months and their chromatic sensitivity and visual acuity rapidly improves over the first 6 months after birth (Franklin et al., 2022). Here, we investigate the visual properties of book images that are 'just right' for engaging infants of different ages. Our previous research has identified a number of chromatic and spatial image statistics that are highly predictive of infants' visual engagement with art and natural scenes (e.g., McAdams et al., 2023), and here we investigate their contribution to infants' visual engagement with books.

Method: Thirty-seven 3-12 month-old full term infants took part. Infants were shown single digitized pages of 50 square format books designed for infants and young children, with images presented individually and centrally on a grey background via a color-calibrated computer monitor. Each image was presented for 8 seconds whilst eye-movements were recorded with an eye-tracker, and the

commencement of each trial was contingent on infant fixation of a centralized attention getter. Image analyses computed a set of chromatic and spatial image statistics for each image, including the amount of saturation and luminance contrast, the proportion of pixels of a given hue, the fractal dimension (the extent to which patterns repeat on different spatial scales), and a set of edge statistic measures (e.g., edge density and edge orientation entropy).

Results: Partial least squares regressions (PLSRs) identified that over one third of the variance in infant looking time could be accounted for by a combination of image statistics, and the model was highly similar for younger and older infants. Image statistics that captured the chromaticity and luminance of the images were better predictors of infant looking time than the spatial image statistics. Infants looked longer at book pages the more highly saturated and dark the image colors were, the greater the amount of saturation contrast, and the higher the proportion or saturation of red and blue pixels. The book pages that infants looked at the least were all achromatic (black and white) or had highly de-saturated (pastel) pixel colors.

Discussion: The findings provide further evidence that infants can extract certain statistics from images, and show that infants from 3-months are particularly sensitive to the color and luminance of a complex image. The findings also provide clear guidance on the type of books that babies find visually engaging. We identify a set of principles that enable book designers to calibrate books to the visual abilities of infants of different ages.

P1-F-116 - Exploratory behaviors of walking infants during a locomotor task

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Details

Exploration during goal-directed locomotion is typically described as automatized. With a quick glance, experts can judge whether they should proceed as usual or devise an alternative locomotor strategy (Adolph et al., 2000). For novices, however, this may not be the case. On an embodied cognition account, novices, such as newly walking infants, must allocate attention to their new skill at the cost of attention to cognition. For example, on a locomotor task where infants had to navigate a tunnel to reach their caregivers, novice walkers struggled to inhibit their preferred locomotor method of walking to fit their body into the tunnel and crawl through (Horger & Berger, 2023). The motor demands of maintaining balance in their new posture induced inhibitory errors, indicating a trade-off of attention from cognition to action. However, whether infants' exploration in a locomotor task is similarly impacted by motor expertise has not been investigated. Thus, the current study used head-mounted eye-tracking during a locomotor task to ask how newly walking infants visually and haptically explored during the tunnel task, and whether exploration during this challenging task was coordinated. Previous work suggests that coordinated visual and haptic exploration facilitates infants' use of information gathered from the explored object better than uncoordinated exploration (Wilcox et al., 2007).

5 walking infants (M_{age}= 16.94 months, $M_{walkexperience}$= 1.79 months, 3 male) who no longer crawl have participated thus far. Data collection is ongoing. Infants wore a head-mounted eye-tracker and were

placed in front of a shoulder-high tunnel with their caregiver at the other end coaxing them to enter. We identified 8 areas of interest (AOIs) for looking and 11 tunnel-specific haptic behaviors. A primary coder used Datavyu video coding software. The first coding pass captured looking from eye-tracker footage. The second pass captured touching from the third-person footage. A coder categorized each look or touch and the video frames marking the onset and offset of the behavior. We calculated duration of each look and each touch and classified concurrent looking and touching by identifying the frames where look and touch overlapped.

Out of 90 haptic and look behaviors documented, 12 were coordinated looks and touches. Infants spent 49% of the time looking at an AOI and about 26% of the time haptically exploring, but only an additional 17.5% of the time simultaneously looking and touching. Thus, as a group, infants were not coordinated explorers. These data indicate that exploration is effortful, not automatized, for novices facing challenging locomotor tasks. The uncoordinated nature of exploration may explain why newly walking infants are prone to errors on this task. If infants allocate attention to maintaining balance control, then in addition to being unable to inhibit, they may also not be gathering the relevant information to solve the problem. Upon completion of data collection, we will compute infants' proportion of coordinated looks and touches out of all exploratory behaviors and run correlations between these proportions and infants' walk experience. This will allow us to investigate the role of motor experience in exploration.

P1-F-117 - Does exploration through self-locomotion explain the relation between infant walking experience and selective attention?

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Details

Introduction. The transition from crawling to walking dramatically changes the way infants perceive the world and how they explore it. Previous work showed that this transition is linked to developmental advances in exploration and in cognitive domains such as spatial memory and vocabulary. While a number of mechanisms have been suggested to explain the relation between walking and cognitive development, evidence is scarce. In a previous study, using the same dataset as in the current study, we found that walking experience positively predicted children's performance on a selective attention task. Thus, selective attention might explain some of the relations between this transition and cognitive development, as selective attention is a central factor underlying learning across multiple domains. Given the link between walking and exploration we here hypothesize that exploration will explain the relation between walking and selective attention. We focus specifically on exploration through self-locomotion, as this type of exploration is most directly related to walking experience.
Methods. Participants were 50 14.5 months old infants (M=14.64, SD=.25; 44% girls). Age of onset of walking was measured using parental reports. During a lab visit, the Alberta Infant Motor Scale was administered to determine current level of motor development and verify parental reports. Exploration through self-locomotion was measured using a free play session where infants played with a set of smaller toys (e.g., blocks, cups) and a set of larger toys (e.g., a tunnel, hoop). For each set, 3 minutes of play were coded in segments of 5 seconds. For each segment a score of 1 was given if the infant was predominately self-locomoting (crawling or walking) and 0 if it was predominantly stationary. The total

score is the proportion of segments where infants were self-locomoting. The mean on both sets was used as the total score. Selective attention was measured using a visual search eye-tracking task, including feature and conjunction (effortful search) items. Success in finding the target was scored if infants fixated on the target at least once. As previous work showed the performance on conjunction trials was related to walking, we focus on these trials.
Results. Mediation analysis, using the PROCESS macro in SPSS, revealed that, as expected, walking experience positively predicted selective attention. However, exploration through self-locomotion did not significantly predict selective attention. Therefore, there is no mediation effect. Additional exploratory analysis showed that both walking experience and exploration positively predicted duration of fixation to the target. Longer fixation duration might indicate higher task engagement and facilitate learning, as the longer you look the more information you obtain.
Conclusion. Findings do not support the hypothesis. A possible explanation could be that our measure of exploration is not sensitive enough as we coded all forms of self-locomotion as equal. Exploration through walking might contribute differently to selective attention than exploration through crawling. We will code the type of self-locomotion infants used while exploring to test this hypothesis. Additionally the relation with fixation duration might indicate another mechanism through which walking and exploration may support learning.

P1-F-118 - Development of face-specific ERP processing in infants from 3 to 12 months of age

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Details

The face inversion effect has been considered the marker for expert perceptual processing. It affects face-specific components of event-related brain potentials (ERPs). In adults, the N170 component shows larger amplitude and delayed latency to inverted than upright faces. Such inversion effect does not occur for non-face stimuli. The face inversion effect occurs in infants at 12 months of age on the N290 and P400 ERP components, but this has not been systematically studied in infants at younger ages. The neural generator of the N290 component has been localized in the middle and posterior fusiform gyri. The present study investigated the effect of face inversion on face-selective ERP components in infants from 3 to 12 months of age. We expected that upright face stimuli would elicit larger responses than other stimuli in face-selective ERP components (N290, P400) but not in non-specific ERP components (P1). There also should be a change from 3 to 12 months in the specificity and amplitude of the face-selective components and changes in the response to inverted face stimuli.

Infants were tested at ages 3, 4.5, 6, 7.5, 9 or 12 months of age. Upright and inverted faces and upright and inverted houses were presented while EEG was recorded. The “event-related-potential” (ERP) to the stimulus onset was quantified for P1, N290, and P400 ERP components. Cortical source analysis was used to estimate the cortical areas generating the ERPs and responsive to the face inversion.

The N290 in response to upright faces increased in amplitude from 3 to 12 months. The N290 in response to inverted faces was smaller at 3 mo. than to upright faces, but increased in amplitude from 3 to 12 months. At 12 months the N290 to inverted faces was slightly larger than the N290 to upright faces. The P400 was larger to upright faces than inverted faces at ages but 3 months. The N290 and P400 were larger to faces than to houses; these components do not differ between upright and inverted houses. The source activity of the N290 in the right middle fusiform gyrus showed a linear increase across age for upright faces; both left anterior and middle fusiform gyri showed a quadratic increase over this age range to upright and inverted faces, but not to houses.

These results show changes over age in the ERP responses to inverted faces was different than the changes to upright faces, whereas the changes in the ERP to upright and inverted houses did not differ. At 12 months the N290 to inverted faces was slightly larger than upright faces, whereas the P400 to upright faces was larger than to inverted faces. These results do not unambiguously support the ERP to inverted faces as an indicator of expert face perceptual processing in infants. However, they show that infants distinguish between upright and inverted faces and that source generators for upright faces closely follow the ERP responses and by 12 months are similar to adult generators.

P1-F-119 - Shorter duration of night waking at 24 months and math achievement at third grade: The role of memory

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Details

Objective: Frequent night awakenings during infancy and toddlerhood are associated with poor cognition (Scher, 2005; Sun et al, 2018). Yet, sleep is critical for the consolidation of memory and learning. Shorter and fewer night awakenings during toddlerhood, however, may result in less fragmentation and facilitate the encoding of information and formation and retrieval of memories. This, in turn, may predict better academic achievement.

Few studies have examined the mediating role of memory during preschool on links between shorter and less frequent night waking during toddlerhood and better math achievement. Given the importance of memory for math achievement (Bull et al., 2008; Coolen & Castronovo, 2023), we address this gap.

Methods: We used data from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development Study (n = 1364) to test whether memory at 54 months mediates relations between night waking at 24 months and math achievement at 3rd grade (ages 8-9 years).

At 24 months, mothers reported the average duration (minutes) that their child was awake during the night (values were multiplied by -1 so that higher scores reflected shorter wake duration). Mothers also reported the average frequency of night waking. Memory was assessed using the Memory for Sentences Test of the Woodcock-Johnson -Revised Tests of Cognitive Ability at 54 months (WJ-R; Woodcock & Johnson, 1989; Woodcock, 1990). Broad math achievement (Calculation, Math Fluency, and Applied Problems) was assessed using the WJ-R Tests of Achievement at grade 3. The mediating role of memory at 54 months in the association between average night waking at 24 months and math achievement at 3rd grade was analyzed via path models that controlled for maternal age, years of education, household income, child sex, and difficult temperament.

Results: Shorter average duration of night waking at 24 months predicted better memory at 54 months and, in turn, higher math achievement at 3rd grade (Figure 1). The indirect effect of memory on the relation between shorter average duration of night waking and higher math achievement at 3rd grade was tested with bootstrap methods (MacKinnon et al., 2004). With the number of resamples = 200, the mean indirect effect was .02, $p < .001$, which fell between a bias corrected 95% confidence interval (CI) of .01 and .04. The mean direct effect was .04, $p = .11$, bias corrected 95% CI [-.01, .09]. The mean total effect was .07, $p < .01$, bias corrected 95% CI [.007, .126]. Memory at 54 months did not mediate the relations between lower average frequency of night waking at 24 months and math at 3rd grade.

Conclusion: Shorter durations of night waking at 24 months may be associated with more consolidated sleep. This may facilitate encoding of information and memory formation during early childhood and, in turn, long-term math achievement. Greater attention is needed on night waking during toddlerhood and links with school-age outcomes. Early messaging regarding the finding of links between shorter night waking and better memory and math may be useful for parents.

P1-F-120 - Infants can build panoramic scene representations from different viewpoints

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Details

When an infant is playing on a mat, she knows where to turn her head to look for her parent who is not directly in front of her. To accomplish this, infants need to build a panoramic scene representation in their mind and mark their parent's relative location in it – this requires holding and integrating a large amount of visual information. Studies have shown how adults "stitch together" scenes from snapshots (Park and Chun 2009; Robertson et al. 2016). Infants can accumulate information about objects in a scene through separate viewings (Guillory and Kaldy 2019) and can use the gist of a natural scene to detect the change (Duh and Wang 2014). However, no study yet has investigated whether infants can build integrated panoramic scene representations from different snapshots.

In the current study, we investigated this by testing how infants search for a target in a cluttered (computer-generated) room. Critically, on each trial, infants saw a snapshot of the room, but from a different viewpoint (8 viewpoints total, varied trial-to-trial). In the *Same Place* condition, the target (an open laptop) always appeared in the same location in room-centered coordinates (e.g., on the table), no

matter the viewpoint. In the *Different Place* condition, the target appeared in a different location in each snapshot (e.g in Trial1, on the table; in Trial2, on the couch). In both conditions, the target's absolute location on the screen (in screen-centered coordinates) varied (among 8 possible positions), due to the changes in viewpoint (Figure 1). This is a variant of the classic contextual cueing paradigm (Chun and Jiang 1998), but with computer-generated 3D natural scenes. Will infants build a panoramic representation of the room from snapshots that can be exploited to guide search when the target always appears in the same place?

Our study was preregistered (https://osf.io/9vmbn). We tested 36 infants (17 females, mean age = 16.25 m, range: 13.52–21.69 m). There were 16 trials in each condition with two trials for each viewpoint. The order of conditions was counterbalanced among participants. A trial began with the onset of the snapshot of the room. To incentivize infants to actively search for the target (an open laptop), a reward (a brief clip from Teletubbies) appeared on the screen of the laptop after 3s - 4s had elapsed. We used a Tobii eye-tracker to collect infants' eye movement data. Our main measure was the time of first fixation at the target (TFF) after the snapshot appeared (but before the reward animation began).

Our results showed a significantly lower TFF to the target in the condition where the target always appeared in the same (room-centered) location (Figure 2, *Same Place*: 1447.92 ms, *Different Place*: 1726.56 ms, $F = 11.69$, $p < 0.001$, $d = 0.14$). These results provide evidence that infants can integrate scene information incidentally from snapshots (acquired from varied viewpoints) and use it to facilitate search.

P1-F-121 - Understanding light is key for conceptualising the prenatal visual system

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Details

It has long been known that the uterus is a rich sensory environment. Only recently has fetal vision been considered within this framework. Importantly, models of exogenous light penetration to the uterus indicate that it is not dark during development. Given evidence for light in the womb, what does this mean for the development of the visual system across gestation?

First, we must consider the role of light in the formation of the visual system. I will present a new monte carlo computational model of how light interfaces with different layers of maternal tissue. This work utilises published data on the biophysical properties of skin, muscle, adipose, uterine wall, and amniotic fluid. The model indicates that there is sufficient light in the uterus to enable a visual experience by the fetus during the third trimester. This varies as a function of maternal abdominal adipose. The luminance levels within the uterus across gestation are not yet known. Importantly, animal models suggest that light is essential for the formation of the visual system, with recent developments in atypical opsin research pointing to the critical nature of light during the formation of the functional brain. There is also evidence that prenatal visual experience impacts upon postnatal visual capacities in animals and humans. For this reason, light should also be considered when indexing the formation of

circadian rhythms. Finally, the question of how light influences sensory development will be explored, with the possibility that fetal body and limb movements could serve as a fundamental stimulus within the uterus. As such, cross-modal processing, embodiment, and multisensory development are likely topics that require reappraisal given the implications of light in the uterus. I argue that understanding light is essential for conceptualising not just the prenatal visual system, but a wide variety of psychological constructs in early human development.

P1-F-122 - Cortical markers of habituation in infants with a family history of autism

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Details

The electroencephalogram (EEG) is an affordable and non-invasive measure of cortical activity in human subjects, including infants, which is frequently used to measure neural differences arising in neurodevelopmental disorders. While several EEG phenomena have been used as key measures to assess differences in cortical function for purposes of diagnoses, stratification, or assessment of response to treatments in psychiatry and neurology, there is rarely an understanding of the underlying cortical processes that give rise to each aspect of the EEG signal. Among the most studied aspects of EEG phenomenology is mismatch negativity (MMN), which is expressed as an increase in the magnitude of cortical event-related potentials (ERPs) occurring in response to an unexpected or 'oddball' stimulus embedded in a sequence of familiar, expected stimuli with otherwise equivalent features. The striking and reliable MMN effect is often dysregulated in neurodevelopmental disorders such as intellectual disability, Autism, attention-deficit hyperactivity disorder (ADHD), epilepsy, and schizophrenia. Recent work has indicated that GABAergic inhibitory neurons in the neocortex play a key role in MMN.

Here we present work investigating habituation using an EEG auditory MMN paradigm in 14-month-old infants to examine cortical markers of MMN in infants with an elevated likelihood of Autism. Infants recruited into BASIS phase 2 (British Autism Study of Infant Siblings) underwent an auditory oddball paradigm consisting of pure tone 'standards' and two 'deviant' or infrequent tones (a vowel deviant and a pitch deviant). Analysis will be completed to investigate evoked gamma, inter-trial phase coherence, change detection and repetition suppression to analyse habituation across the paradigm. Comparisons will be made initially between enrolment groups - 'Typical likelihood of Autism' (n=27), Elevated likelihood of Autism' (n=113), with further comparisons based on outcome data - 'Typical likelihood of Autism' (n=27), 'Elevated likelihood – Autism' (17), 'Elevated likelihood – typically developing'(n=64), with a potential fourth group 'Elevated likelihood – other' (n=32). This analysis has been pre-registered (AsPredicted #153760). This work additionally aims to translate findings to pre-clinical studies of MMN investigating the cortical mechanisms and involvement of inhibitory interneurons during MMN.

P1-F-123 - Visual scanning of audiovisual social events at 6 months predicts internalizing and externalizing symptomatology at 18 months

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Details

Individual differences in attentional biases to threat contribute to the development of internalizing and externalizing psychopathology in children (Dudeney et al., 2015). Normative attention biases to threat are evident during infancy but may become perturbed later in development in children at risk for anxiety. However, research assessing attention biases to threat often use static stimuli, neglecting the dynamic, multisensory nature of threatening events. Recently, we demonstrated that individual differences in "multisensory attention skills" (MASks; e.g., maintaining and disengaging attention, matching synchronous sights and sounds in dynamic audiovisual events) predict social, cognitive, and language outcomes in typically developing children (Edgar et al., 2022, 2023; Ramirez et al., submitted; Testa et al., 2023). Here, we extend our prior findings by assessing whether at 6-months, a basic index of attentional scanning "breadth" (i.e., extent of visual scanning among 6 concurrent events in the presence of a soundtrack matching one of the events), predicted internalizing and externalizing symptomatology at 18-months. We addressed this question using a newly-developed, fine-grained individual difference measure of multisensory attention to audiovisual events, the Intersensory Processing Efficiency Protocol (IPEP; Bahrick et al., 2018). Given that maternal depression is a well-established predictor of child psychopathology (Goodman et al., 2011), we controlled for it in our analyses. Infants (*N*=99) participating in a longitudinal study received the IPEP at 6-months. IPEP trials depicted a 2x3 grid of 6 areas of interest (AOIs; Figure 1). AOIs depicted 6 social events (women speaking) or 6 nonsocial events (objects dropping into containers and making sounds). The event in only one AOI was synchronous with its appropriate soundtrack. *Predictors:* At 6-months, audiovisual scanning of social and nonsocial events was calculated as the number of AOIs fixated in each trial and then averaged across trials (range:0–6). *Covariate:* At 6-months, mothers completed the Edinburgh Postnatal Depression Scale (Cox et al., 1987). *Outcomes:* At 18-months, parents completed the internalizing and externalizing sub-scales of the Infant-Toddler Social and Emotional Assessment (Carter & Briggs-Gowan, 2006). We conducted multiple regression analyses to assess whether 6-month audiovisual scanning would predict internalizing and externalizing symptomatology at 18-months, holding maternal depression levels constant. Results indicated that audiovisual scanning of social events at 6-months predicted symptoms of internalizing and externalizing at 18-months (*p*s<.05; Table 1), holding constant maternal depression. Infants who showed greater audiovisual scanning of women speaking showed fewer internalizing and externalizing symptoms 12-months later. In contrast, scanning of nonsocial events did not predict any outcomes (*p*s>.75). Findings demonstrate that infants who fixated a greater number of social (but not nonsocial) events showed fewer internalizing and externalizing symptoms 12-months later, even after controlling for maternal depression levels. Thus, infants who distribute their visual exploration more broadly to social events have better psychological outcomes in toddlerhood. Our findings are the first to demonstrate that a basic index of attention (visual scanning breadth) in the context of social multisensory events predicts later psychopathology in a community sample of toddlers. This suggests the IPEP may be used to identify those at risk for later internalizing and externalizing issues.

P1-F-124 - Infant attention-following in laboratory and home settings from 4 to 9 Months

ICIS 2024 Abstract Book

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Details

Acquisition of attention-following (AF) skills contributes to social learning and communication. However, the development of AF in early infancy remains controversial, partly due to differences in testing methods and contexts. Previous studies of infant AF were conducted in either naturalistic or laboratory settings (Deak et al., 2008; Yu and Smith, 2013). Deak et al. (2017) observed that during home dyadic play, North American mothers used a variety of behavioral cues to direct infants' attention, including verbal, gaze, pointing, and manual actions. By contrast, laboratory studies tend to focus on isolated gaze or pointing cues to direct infants' attention (e.g., Butterworth & Jarrett, 1991). Because home-based and lab-based studies differ in the cues used and other contextual factors, it is difficult to reconcile results from these two common research settings.

Our previous study examined infants' AF monthly from 6 to 9 months in both home and lab settings, revealing significant differences in AF trajectories between the two settings (Tang et al., 2023). However, it left questions about how AF skills first emerge across social settings. One outstanding question is whether AF might emerge before 6 months of age, especially in home settings: Tang et al (2023) found some AF at home by 6 months of age, whether AF in the lab did not exceed chance until 7 months. However, other studies reported gaze-following in infants 4 months or younger (e.g., Hood et al., 1998); though these were confounded and thus hard to interpret. The current study extends previous findings by examining infants' responses to mothers' attention-directing cues at home at 4 and 5 months, to compare trajectories of AF at home and lab settings from 4 to 9 months, including individual and contextual factors.

Infants (N=43) from a Southern California city were videotaped every month from 4 to 9 months of age in an unscripted JA task at home with their mother, and in a laboratory setting with an experimenter who produced scripted attention-directing cues (gaze, point, and gaze-plus-point; see Tang et al., 2023).

Initial results showed increasing AF with age in both home and lab settings, but with different trajectories (see Figure 1). Infants demonstrated more overall following, higher month-to-month average similarity, and greater variability at home than in the lab. We also assessed the consistency of individual infants' AF between home and laboratory settings. Initial analyses revealed non-significant monthly correlations between home and lab performance, suggesting distinct AF tendencies across contexts (Table 1). This suggests that infants' responses to attention cues do not generalize across settings. Ongoing analyses are examining how behavioral and contextual factors including cue duration, cue frequency, and mothers' infant-directed speech affect infant AF variability in the home setting.

Our extended analysis indicates that infants did not reliably follow attention until 6 or 7 months, respectively, in home or lab settings. This suggests that infants show different patterns of AF in different settings, show limited stability even within a setting, and do not reliably follow attention in either setting before 6 months of age.

P1-F-125 - Learning words through exploration: trait curiosity at 11 months predicts productive vocabulary at 24 months

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Details

Infants learn new words by interacting with their environment and social others. Based on their curiosity, infants and toddlers actively request information from adults through social orienting (Bazhydai et al., 2020) and pointing (Liszkowski et al., 2007), with learning benefits shown for such actively requested information (Begus et al., 2014). Therefore, it is likely that a child's curiosity helps shape their everyday learning experiences and consequently their language development. Indeed, there are several studies that relate observed differences in early exploration behavior to relate to variability in learning, later vocabulary, cognitive development, and academic achievement (e.g., Berg & Sternberg, 1985; Bornstein et al., 2013; Muentener et al., 2018; Yu & Smith, 2013) highlighting its role in and importance across development. Up until now, however, there has been no way of reliably measuring such individual differences as a trait measure. We developed and validated the Infant and Toddler Curiosity Questionnaire (ITCQ, Altmann et al., under review) to fill this gap.
The current study collected longitudinal data from N = 28 infants (12 females, 16 males) employing the ITCQ at 11 months (M = 11.2, SD = .54) of age as a predictor of scores on the Oxford CDI (Hamilton et al., 2000) at 24 months (M = 23.9, SD = .31). While there was no direct relation between the mean overall curiosity score and neither between curiosity and the comprehensive vocabulary scores, we did find that the three exploration sub-factors significantly predicted productive vocabulary, jointly explaining 52% of variance in the data ($F(4, 23) = 6.169$, $p = .002$). Specifically, we found that higher scores in both investigative ($b = 91.58$, $p = .012$) and social exploration ($b = 68.03$, $p = .006$) predicted a larger vocabulary, whereas sensory exploration formed an inverted u-shaped relation with later vocabulary (linear term: $b = -157.83$, $p = .001$; quadratic term: $b = -150.65$, $p = .003$), hinting at a possible mal-adaptive facet of curiosity. These results offer first indications of a longitudinal relationship between infants' trait curiosity and productive vocabulary development. Importantly, they imply limits to the beneficial effects of curiosity and a possible path towards later deficits in sustained attention.

P1-F-126 - Exploring the dynamics of joint attention measures in predicting language abilities

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Details

Joint attention (JA), the active coordinated shared attention in an infant-caregiver interaction on an object or action of interest (Tomasello & Todd, 1983), has been repeatedly shown to be associated with a child's later language abilities (e.g., Yu, Suanda & Smith, 2019). However, the definition and metrics of JA vary across studies, leading to challenges in comparing results. Some studies define JA based on the alignment of gaze onto an object or action of interest (Associative Accounts), while others emphasize interactional and intentional aspects, requiring awareness of each other's attentional state (Social

Accounts). Due to the differences in definitions, it is unclear which aspects of JA influence language acquisition. In our study, we applied two established JA metrics representing the two accounts to the same naturalistic play dataset. We aim to a) compare various JA measures surrounding caregiver naming events (NE); b) investigate if any of those measures derived predicts vocabulary size.
Method: Using video recordings of naturalistic toy-play interactions from 47 British-English-speaking 12-month old infants and their caregivers, we coded JA events surrounding object NE using two JA coding schemes established in two previous studies (associative account: Yu and colleagues (2019), social account: Gabouer and Bortfeld (2021)). For both metrics, we derived a series of measures related to the general properties of the JA event (e.g. frequency and duration), or to the position of the NE within the JA event (e.g. at which point in time of the JA episode they occur). Out of all measures, four were derived in an identical way from both approaches to allow for direct comparisons. Children's receptive and productive vocabulary at 15 and 18 months was assessed through the CDI.
Results: While measures of JA in these two approaches mostly assessed different characteristics of JA, measures involving NE were highly correlated. Contradicting earlier work (Yu et al., 2019), we did not find an effect of JA or SA on later language abilities using the coding scheme from the associative account. However, using the metric from the social account, our results suggest that some aspects of JA predict later vocabulary size (at 15 and 18 months). Specifically, measures related to the position of the NE within the JA event seem to be a better predictor of later vocabulary size than metrics relating directly to the JA. This suggests that the caregivers modulate the timing of the NE within the JA event, not the JA event itself, which is in line with previous results found using the same coding scheme (Sander et al., 2023).
This study is the first to compare different metrics of JA using the same dataset and investigate the relationship between different JA measures and later language abilities. The two approaches demonstrate substantial differences in the way they define JA episodes in the naturalistic data. Using the social approach, we consistently found that NE within JA episodes significantly influence JA's impact on later language outcomes. Our findings emphasize the complexity of JA measurement and its nuanced relationship with language development.

P1-F-127 - Early infant gender effect on socially organized attention behaviors during interactive play

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Details

Introduction: Visual attention plays a critical role in early learning, such as social, cognitive, and language development [1-5], yet there has been reported individual variability. In particular, prevailing gender differences in attention behaviors amongst school-age children and adults have been reported [6-8]. Despite the importance of attention in learning and development, we know relatively little about what experiences or processes through which individual differences such as gender differences may emerge and how they may be shaped by parental behaviors. The present study captured infant and parent visual attention experiences in a social interactive play context to test the effect of infant gender.

Method: 103 typically developing infants between 3-18 months (Males: n = 44, *M* = 10.87, *SD* = 3.86; Females: n = 59, *M* = 11.35, *SD* = 4.48) and their parents wore head-mounted eye-trackers (Fig. 1) while

participating in a 6-minute parent-infant toy play-session. Gaze data was recorded and coded for what targets each participant looked at (objects, parent hands, infant hands, and face) and joint attention (JA; when parent and infant looked at the same object simultaneously - initiation of JA and response to JA).

Results: A set of MANCOVA analyses (covariate: age) revealed 3 key findings: gender effect on the type of target items (1) infants look at, (2) parents look at, and (3) joint attention. A comparison of infant visual attention to targets indicates a significant effect of child gender and age (Fig. 2A) – post hoc analyses further confirmed that males more frequently looked at hands (parent's: $p = .016$ and infant's: $p = .035$) and older infants looked at targets more frequently ($p = .003$) and longer ($p = .043$). We next conducted the same analysis on parent attention. Parents of female infants looked more frequently, $F(4,91) = 3.123$, $p = .019$, partial $\eta^2 = .121$, and longer, $F(4,91) = 2.781$, $p = .031$, partial $\eta^2 = .109$, at targets (Fig. 2B and 2C) – post hoc analyses further specified that parents of male infants looked more frequently at their infant's hands ($p = .026$) while parents of female infants looked longer at objects ($p = .032$). Parents of older infants also looked more frequently at targets, ($p < .001$), and longer at targets, ($p = .005$) – post hoc analyses further specified that they looked more frequently at their child's hands, ($p < .001$), and objects, ($p < .001$), and longer at their child's hands, ($p = .040$), and objects ($p = .014$). The last analysis regarding the gender effect on JA indicates that parent-female infant dyads had longer average JA instances, $F(3,87) = 2.942$, $p = .037$, partial $\eta^2 = .092$ – post hoc analyses show that they experienced longer average JA instances ($p = .008$) and response to JA instances ($p = .023$).

Conclusion: These findings indicate the early emergence and rapidly changing characteristics of infant gender differences in visual attention and how parents may modify their attention behaviors to their infant's gender and age during play. Future directions include exploring the role of other parental scaffolding behaviors (e.g., object handling) in guiding the dynamics of infant visual experiences and how they may contribute to the resulting gender differences. Discussion will include how the present results may relate to documented gender differences in early neural development and the activation of brain regions associated with attentional and social processing and their developmental significance.

P1-F-128 - Infant attention to multisensory events predicts school readiness in childhood

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Details

Early attentional control (e.g., flexible, efficient, and purposeful orienting, maintaining, and shifting attention) predicts later school readiness outcomes, including early reading, math (Duncan et al., 2007; Rueda et al., 2010), and self-regulation (Reck & Hund, 2011; Geeraerts et al., 2019). However, most studies have assessed attention using questionnaires, static visual images, or videos without sound, limiting our understanding of how attention functions in the dynamic, multisensory environment. To address this issue, Bahrick and colleagues (2020) developed the term "multisensory attention skills" (MASks) to describe four basic attention skills (shifting/disengaging attention, maintaining attention, intersensory matching, and distractibility) and how they function in the context of dynamic, audiovisual events. Using a new measure of individual differences of MASks suitable for infants and children, the Multisensory Attention Assessment Protocol (MAAP; Bahrick et al., 2018), recent findings demonstrate

that MASks predict later language and cognitive outcomes (e.g., vocabulary size, working memory; Edgar et al., 2022, 2023; Testa et al., 2023). The present study extends prior findings by assessing the role of MASks as predictors of a new outcome, school readiness. We predicted that better MASks in infancy will predict greater school readiness (i.e., pre-literacy, pre-numeracy, self-regulation) in childhood.

Children (*N*=90) participated in a longitudinal study from 3 to 72-months of age. *Predictors (MASks):* At 12-months, sustaining attention, intersensory matching, disengaging attention, and distractibility to faces and voices of women speaking in the presence of a distractor were assessed using the MAAP (Figure 1). *Outcomes*: Between 48 to 72-months, pre-literacy was assessed by the Test of Preschool Early Literacy (TOPEL; Lonigan, 2007), pre-numeracy by the Test of Early Mathematics Ability (TEMA; Ginsburg & Baroody, 2003), and self-regulation by the Head-Toes-Knees-Shoulders task (HTKS; Cameron Ponitz et al., 2008). For each outcome (TOPEL, TEMA, HTKS), a mean score was derived by averaging across tests taken at each age (48, 60, 72 months) for each participant.

Correlations were conducted using full information maximum likelihood estimation. *Pre-literacy (TOPEL):* Longer sustained attention to dynamic faces, greater intersensory matching of faces and voices, and lower distractibility from faces and voices (but not disengagement speed) at 12-months predicted higher childhood TOPEL scores, *ps*<.001 across 48-60 months. *Pre-numeracy (TEMA):* Longer sustained attention and lower distractibility (but not intersensory matching, disengagement speed) at 12-months predicted higher childhood TEMA scores, *ps*<.002 across 48-72 months. *Self-regulation (HTKS):* Longer sustained attention and lower distractibility (but not intersensory matching, disengagement speed) at 12-months predicted higher HTKS scores, *ps*<.03 across 48-72 months (Table 1). In sum, results indicate that sustained attention and distractibility to audiovisual social events in infancy predict all three school readiness outcomes (pre-numeracy, pre-literacy, self-regulation) in childhood, and intersensory matching predicts pre-literacy. Lastly, disengagement speed did not predict any outcome.

Findings reveal the foundational role of infant multisensory attention skills in promoting school readiness in childhood. These results can help identify infants at risk for poor academic outcomes, suggesting that attention training targeting sustained attention, intersensory processing, and/or distractibility could improve school readiness outcomes and foster better academic achievement.

P1-F-129 - Does sequence learning engage the frontoparietal network in 8-month-old infants? A replication and extension of Baek et al. (2022)

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Details

Sequence learning is a critical ability which serves as the cornerstone for developing many other cognitive and motor skills (e.g., Säfström et al., 2014), and it appears early in life. For example, 3-month-olds were able to detect audiovisual sequences with 3 elements compared to 4 elements for 4-month-olds (Lewkowicz, 2008), and 11-month-olds were able to respond to spatially structured sequences (Kirkham et al., 2007). Considering the relatively immature brain structure and network connectivity in infants, exploring the underlying neural basis for this ability in early infancy can help with our

understanding of the development and functional capability of responsible networks when compared with findings from adult studies. However, only few studies touched upon this and among which, Baek and colleagues (2022) found an attenuation of frontal, parietal, and occipital responses towards predictable and thus learnable sequences in 6-month-olds. This fNIRS finding corresponds to the reduced prediction error in the predictive coding model (Friston, 2005). Moreover, a significantly greater functional connectivity in the frontoparietal network during predictable sequences (PS) compared to unpredictable sequences (UPS) was revealed (Baek et al., 2022), suggesting the involvement of the frontoparietal network in sequence learning and its early functioning at 6 months. Despite the evidence in adult studies (e.g., Koban et al., 2019; Leong et al., 2017), it was the first study demonstrating the involvement of the frontoparietal network during sequence learning in infant brains. For the current study, we plan to carry out a replication of Baek et al (2022) on 8-month-olds to confirm the potential functional role the frontoparietal network plays during sequence learning on an additional group of infants at a slightly older age, providing more evidence for the neural underpinnings of this ability. Forty infants were recruited and wore an fNIRS headgear (NIRx Sport, 48 channels) when presented with both PS and UPS conditions in a counterbalanced order across participants (i.e., PS first or UPS first). Each sequence has two different elements with each element presenting a smiling shape (green square, yellow crescent, pink star, or blue cloud) moving across the screen upward, downward, leftward, or rightward, accompanied with a sound of old windows startup, rattle, train, or chimes. The pseudorandom pairing between the shape and sound stays the same for one infant throughout the task with two pairs of elements for PS and the other two for UPS. The order of two elements within one trial is AAAB, AABA, ABAA, or BAAA. For PS, one of four orders is randomly assigned to each infant and stays the same for a total of 8 trials and for UPS, four orders are pseudorandomly chosen for each trial. For the analysis, besides the univariate analysis comparing brain activations towards PS and UPS, the background functional connectivity approach, which regresses out synchronized task-evoked responses, will also be applied to examine interactions between regions during learning. A detailed analysis plan is available at OSF. We expect to replicate the attenuation effect in the frontal, parietal, and occipital lobe, as well as the effect of greater functional connectivity in the frontoparietal network during learning in 8-month-old infants.

P1-F-131 - Beyond rigid familiarisation procedures: Infant category learning from naturalistic child-perspective recordings

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Details

The ability to form categories is foundational to various aspects of cognition (Mareschal & Quinn, 2001). However, the current understanding of early category learning is based on rigid experimental tasks which do not reflect the richness and unstructured nature of real-world learning. In typical categorisation tasks, infants are familiarised with a sequence of immediately successive images of category members, presented for a few seconds each (e.g., Eimas & Quinn, 1994). By contrast, naturalistic environments involve variable amounts of exposure and spacing of encounters with category members, interleaved with experiences with unrelated objects (e.g., a brief encounter with a duck outdoors may occur hours before another, longer encounter with a duck in a cartoon).

In this study, we move towards studying categorisation in 12- to 16-month-olds in naturalistic conditions by presenting infants with a first-person perspective video of real-life interactions with objects as a familiarisation phase. Videos used as familiarisation material were obtained with head-mounted camera worn by an infant during dyadic exploration sessions with a caregiver, and contain encounters with six different members of a novel category. We aim to test whether infants watching this video are able to form a mental representation of the category, as demonstrated in a subsequent novelty preference test. We hypothesize that children will successfully learn the familiarised category.

To create the familiarisation videos, we first collected audio-visual recordings from two infants' (12/14 months) first-person perspective via head-mounted cameras, while they explored three rooms resembling a naturalistic environment, with their caregivers (see Figure 1a). The caregivers were asked to use a novel label ("modi") to refer to the novel category. Next, a group of 12- to 16-month-olds was invited to participate in a lab-based eye-tracking task (data collection on-going, current N=15, total aim N=24). First, infants were presented with the familiarisation video. At test, infants saw two novelty preference trials showing an image of a previously unseen member of the familiarised category paired with an out-of-category object that was either dissimilar (Trial 1) or similar (Trial 2) to the familiarised category (see Figure 1b).

For the analysis, we will calculate the proportion of looking directed at the out-of-category object for each test trial, and test (a) whether there is novelty preference, and (b) whether preferences differ by test type. A preliminary analysis (N=15) of preference scores on just the first trial using one-sample t-test indicated that infants performed at chance (M=.50, SE=.06, t(14)=.05, p=.962, d=.01; see Figure 2), with six infants showing novelty preference (>.5). For the completed set, we will also test which factors contribute to test performance, such as age, vocabulary (CDI) and object-directed looking during familiarisation (using area-of-interest analyses; cf. Althaus & Plunkett, 2016).

The findings will provide novel insights into early categorisation by bringing naturalistic aspects of infant-caregiver-object interactions into lab-based experiments. We will discuss which aspects of naturalistic learning may be beneficial or detrimental to learning compared to standard familiarisation with image sequences, and why some infants perform better under these circumstances than others.

P1-F-132 - Effects of stressful procedures and developmental care in the neonatal intensive care unit on the neurodevelopment of preterm infants

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Details

The Neonatal Intensive Care Unit (NICU) could be a risk factor for child development due to the stressful and painful procedures to which the preterm neonates are submitted (Cong et al., 2017; Linhares &

Gaspardo, 2017). The behaviors of stress in the neonatal phase should be managed through environmental strategies of developmental care that support the biobehavioral regulation of the neonates to minimize the negative impacts of stress on their neurodevelopmental outcomes (Silva et al., 2018; van Dokkum et al., 2021). The aim of the study was to examine the predictive effect of stressful procedures and developmental care strategies in the NICU environment on neurodevelopmental indicators of preterm infants at 37 weeks post-conceptional age. In the neonatal phase, during the preterm infant's hospitalization in the NICU, the stressful procedures of the NICU were recorded in the medical records and were assessed by the Neonatal Infant Stressor Scale - NISS (Newnham et al., 2009). The NICU developmental care strategies were assessed using an observation protocol of the core measures of protected sleep, pain and stress assessment and management, developmental activities of daily living, and family-centered care (Coughlin et al., 2009). In a second phase, the neurodevelopment of infants preterm, upon reaching 37 weeks of post-conceptional age, was assessed using the Neurobehavioral Assessment of Preterm Infants – NAPI (Korner et al., 2000). The descriptive statistical analysis, correlation, and multiple linear regression analysis were performed, accepting the variance inflation factor (VIF) < 2 (SPSS, version 23.0). The level of significance of the study was $p \leq 0.05$. The results showed that fewer stressful procedures and more developmental care strategies for pain and stress assessment and management during NICU hospitalization predicted a 15% variability of higher scores in the neurodevelopmental indicator of alertness and orientation at the 37th week of post-conceptional age ($p = 0.009$). In addition, 9% of the variability of lower scores in the neurodevelopmental indicator of percent sleep rating was explained by more developmental care strategies in the NICU environment ($p = 0.02$). In conclusion, the developmental care strategies of the NICU were an environmental protection predictor in early neurodevelopmental indicators of biobehavioral regulation and alert system in preterm infants. The developmental care protocol in the NICU should be targeted, especially for preterm infants, aiming to neutralize the negative impact of stressful events on their early development.

P1-F-133 - Early sex differences in attention to the mouth as a female protective candidate mechanism in autism spectrum disorder

Itziar Lozano Sánchez [1], **Elena Capelli** [2], **Charlotte Viktorsson** [3], **Anna Duszyk-Bogorodzka** [1], **Anna Malinowska-Korczak** [4], **Terje Falck-Ytter** [3], **Teodora Gliga** [5], **Emily Jones** [6], **Valentina Riva** [2], **Przemyslaw Tomalski** [4]

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Details

Females are four times less likely to present Autism Spectrum Disorder (ASD) than males (Zeidan et al., 2022). This female resilience extends to the language atypicalities usually associated with the disorder, which are also more often found in males (Harrop et al., 2021). The Female Protective Effect Hypothesis (*FPE*) proposes that females need to accumulate more risk factors than males to develop an ASD phenotype and linked language atypicalities, or may carry more protective factors than males (Wigdor et al., 2022). However, the exact nature of these factors remains unclear.

In the general population, sex differences in language development are well-documented, with females outperforming males as early as age 2 years (Riva, 2021). Early sex differences in attention to the mouth in talking faces may underlie these differences. More mouth-looking in infancy predicts better later language in all infants (Belteki et al., 2022), but this mechanism seems more crucial for females' language development. In the first year, female infants look more to the mouth than males, and reduced mouth-looking at 5.5 months relates to a female-specific advantage in vocabulary skills at 2 years (Lozano et al., 2022). Unique female eye-gaze patterns to the mouth in infancy may be an early protective factor for language development.

ASD is highly heritable (Bai et al., 2019). The disorder and linked language atypicalities usually extend to first-degree relatives, such as infant siblings at elevated likelihood of autism (Hudry et al., 2014). This population allows searching for sex-specific protective factors operating early in life before ASD and language difficulties emerge. Our study investigates whether increased mouth-looking protects female infants at elevated likelihood for ASD from later language atypicalities.

We will track sex differences in mouth-looking in infants at elevated (EL; n=351) and low likelihood for ASD (LL; n=125) during the first year of life and its relations with language outcomes in toddlerhood. Longitudinal existing data from three Babylabs (CBCD lab, UK; MEDEA Babylab, Italy; DiVE Lab, Sweden) across two eye-tracking tasks (screen-based and during 'live' interaction with others) will be analyzed. Mouth-looking will be related to infants' later language scores in standardized tests and parental questionnaires.

In this pre-registration poster, we hypothesize that (H1) female infants will show increased mouth-looking across the first year regardless of ASD likelihood status, and (H2) only in female infants increased mouth-looking during infancy will predict better language skills in toddlerhood.

To test H1, we will run a Linear Mixed Model on the proportion of looking time to the mouth, with ASD Likelihood and Sex as predictors. We predict a main effect of Sex, with females showing more mouth-looking than males, and a main effect of ASD likelihood, with EL infants showing less mouth-looking than LL infants. No significant interaction between sex and ASD likelihood is expected, suggesting increased mouth-looking as a female-specific protective factor regardless of ASD likelihood status.

To test H2, we will run correlations between mouth-looking and language outcomes. We expect positive associations in female infants, but not male infants.

Our large-scale approach will show how generalizable mouth-looking is as a potential female protective factor across contexts, countries, and time. Results may shed light on whether sex-specific protective factors may compensate for genetic risk factors affecting infant siblings, informing potential sex-specific intervention needs.

P1-F-134 - Native and non-native audiovisual language processing in infancy

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Details

Newborn infants show a preference for speech-like stimuli, suggesting infants are born experience-expectant for linguistic stimuli. Despite the immaturity at birth, the visual system is the fastest developing sensory system postnatally. Four-month-old infants can discriminate among languages based on visual facial information alone, further highlighting the quick maturation of the visual system. Adult studies have shown visual speech can travel to temporal cortices even before auditory input arrives to cause a phase reset and induce oscillatory patterns necessary for audio-visual speech integration. Thus, we hypothesized young infants must exploit different systems to process static visual images vs. dynamic audiovisual stimuli containing speech content and that they are capable of audiovisual integration to identify faces talking in their native language.

In this project, we designed an audio-visual oddball paradigm to test 6 to 8-month-old Spanish and/or Catalan native infants' neural responses to native and foreign phonemic contrasts. We obtained good quality data of 28 infants (11 female) with an average age of 6.82 months from Barcelona, Spain. For the experimental procedure, the audio standard stimuli consisted of the Catalan/Spanish native contrast /da/ and the audio deviant stimuli consisted of the English contrast /tha/. Visually, there was no distinction among the faces, given all the faces were producing the same native viseme /da/. Thus, for a baby to know a particular face had a different linguistic background, he or she would have to match the audio information with the visual input. The infants watched a total of 288 trials (1.75s each, 72 deviant), adding up to a total time of 10 min. To measure brain responses, we used a 128-sensor HydroCel Geodesic Sensor EEG Net and impedances were kept below 100 kΩ where possible. Data pre-processing and epoching was carried out using the APICE pipeline (Fló et al., 2022). Cluster analysis was used to identify channel clusters with greater response variability during static face viewing versus during ongoing audiovisual presentation.

Results suggest the cluster of channels active while seeing the static faces was much smaller and confined to the occipital region, while the cluster that was more active during audiovisual processing comprised additional occipital channels and a few posterior temporal ones. Although much smaller in amplitude relative to the mismatch observed after auditory onset, the classical mismatch response was also observed around mouth movement onset. In conclusion, infants at this age appear to engage different systems to process static versus dynamic audiovisual input. In addition, we speculate infants are capable of matching auditory and visual input to learn which faces are talking in their native language, even when audiovisual information is incongruent. Potentially triggering different activity patterns to faces talking in their native contrast as soon as the mouth starts to move.

P1-G-135 - Examining the influence of early shared book reading behaviours on infants' language and cognitive development at 18 months

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Details

Shared book reading is a highly effective home learning activity that can promote young children's language and cognitive development (Hoyne & Egan, 2019; Murray & Egan, 2014). Many families in Western society now begin sharing books with their infants well before they are fluent talkers, with

research showing these are rich social and linguistic interactions (e.g., Ho et al., 2023; Karrass & Braungart-Rieker, 2005, Leech et al., 2022; Murray & Egan, 2019). For example, in Ho et al. (2023), mothers of 6- to 12-month olds were observed to produce attention attracting behaviours, encourage book engagement (e.g., pointing, turning pages), respond contingently to infant verbalisations, and engage in talk that goes beyond the text in the book. The purpose of the present longitudinal study was to investigate longer-term effects of maternal early shared book reading behaviours on infants' communication, language, and cognitive development at 18-months.

Seventeen mother-infant dyads were observed in a laboratory setting engaging in a shared book reading activity when the infant was aged either 6- or 9-months-old (59% males; n = 10). Videos were manually transcribed and coded using NVivo for maternal talk and behaviour. At 18-months of age, infants' vocabulary was measured using MacArthur-Bates Communicative Development Inventories Vocabulary Checklist Form (MB-CDI; Fenson et al., 2007), while infants' communication and problem-solving skills were measured using age-appropriate Ages and Stages Questionnaire (ASQ; Squires & Bricker, 2009).

Our main findings revealed that maternal engagement in non-immediate talk (e.g., talk that goes beyond the book such as making connection to the real world) during shared book reading significantly predicted infants' later communication skills, $F(1, 15) = 9.26$, $p = .008$, $R^2 = .38$, adjusted $R^2 = .34$, and vocabulary development at age 18 months, with a moderate effect found, $F(1, 15) = 8.77$, $p = .010$, $R^2 = .36$, adjusted $R^2 = .32$. Additionally, engaging in affectionate and nurturing behaviours when sharing books also significantly contributed to infants' later vocabulary knowledge, $F(1, 15) = 4.67$, $p = .047$, $R^2 = .24$, adjusted $R^2 = .19$. On the other hand, engaging in directives and organisational talk negatively predicted infants' later vocabulary development, $F(1, 15) = 4.67$, $p = .047$, $R^2 = .24$, adjusted $R^2 = .19$.

The different approaches parents engage in when sharing books with young infants may uniquely foster infants' early language experiences and have lasting benefits on language acquisition. Using books as a medium to engage in cognitively demanding yet meaningful talk (e.g., talk outside of the book, including linking back to the real-world experience) in a nurturing manner offers mothers effective opportunities to facilitate infants' attention, interest and engagement during book reading activities. Future studies are needed to examine these relationships with a larger sample size and across families of diverse cultural, linguistic, and socio-economic backgrounds, including the unique role of fathers and extended family such as grandparents as reading partners.

P1-G-136 - Spatial language in book reading and play

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Details

Prior research has shown that variability in parents' spatial language input predicts children's spatial language production, and that children who produce more spatial language are more likely to perform well on spatial tasks as they grow older (Pruden et al., 2011). Some research has extended this into play; parents who believe that academics are more important than play in their child's development tend to provide lower quality language input during play (Fogle, 2003). In the current study, we examine factors

that influence individual differences in parent spatial language use in two types of parent-child interactions.

Parent-child dyads (n = 75, mean child age = 3.52 years, range: 2-4 years) were given the book "Flashlight" (Figure 1; Boyd, 2014), which is a picture book with no words. The pictures and events in this book offer opportunities to use spatial language while reading, though the content is not explicitly spatial. Parents were instructed to read aloud to their child and construct a story to go along with the pictures with no time limit. Once they were done, dyads were given a set of Mega Bloks to play with for 5 minutes. Parents were then asked to complete a series of questionnaires pertaining to their child's language ability, their child's motor and communication skills, and their own beliefs around play and academics. The video recordings from each session were then manually transcribed and coded for gesture use, different styles of play, and types of language used by both parents and children.

Preliminary results from 13 dyads from the book-reading interaction demonstrate wide variability in parent and child language use (Figure 2). Parents used a varying range of total spatial words (range: 94-236), with children's total spatial word use also varying, though less so (range: 11-47). We examined differences in unique words parents and children used by categorizing words into five categories: animals, colors, numbers, questions, and spatial words. Of the five categories, spatial words were the most commonly used among both parents and children followed by animal words. Parents used more question words (e.g., who, what) than children; parents used almost a third more question words overall than children. On the other hand, number words were used in similar amounts between parents and children. In future analyses, we will explore possible reasons for why these differences may arise.

We plan to complete analysis on data already collected from 75 participants by the 2024 conference and will examine relationships between parent and child language use, gesture use, play style, parent play beliefs, and demographic variables, both within and between the two interaction types. By studying possible elements that may affect the type of language input a child is getting from their parent, such as parent beliefs around play and academics, we can examine how seemingly small factors may be impacting a child's cognitive development long-term. Looking at spatial language and gesture use specifically during book reading and play allows us to expand on prior research by examining if parental input may be moderated by the level of spatial involvement a task requires. Through these open-ended tasks, we can study differences in how parents and children use and understand spatial communication in everyday interactions.

P1-G-137 - The influence of stress on the understanding of goal-directed actions in infancy

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Details

Mild acute stress is present in infants' everyday life, but its effect on their cognition is experimentally largely unexplored. Studies with adults indicate that stress leads to simpler, more rigid thinking strategies in relation to one's own actions and those of others: People are more likely to show habitual behaviors under stress, even if these no longer lead to the aspired goal (Schwabe & Wolf, 2013;

Seehagen et al., 2015). Additionally, they expect the same from other people (Witt et al., 2020). The present pre-registered study tested whether infants who are mildly stressed likewise interpret the actions of other people in a simpler way than infants who are not stressed.

Eighty-six infants aged 6 to 7 months were randomly assigned to a stress or a control condition in which either a stress induction using the still-face paradigm or a free-play phase with the accompanying parent was carried out. Pre and post stress levels were assessed via parental rating and saliva cortisol. Twenty minutes after manipulation onset, a looking time experiment started (Woodward, 1998). During an initial habituation phase, infants watched videos in which one of two objects (teddy or ball) were repeatedly grasped by a human hand. At test, infants watched videos in which the positions of the objects were reversed and the objects were grasped alternately. Looking times to habituation and test trials were coded online. Previous studies had shown that non-stressed infants look longer to the hand grasping the new object at the old position at test. This suggests that they were previously habituated to the goal of the grasping movement instead of the biological movement. We expected to replicate these findings in the control condition. We further expected that stressed infants would habituate to the biological movement and hence to spend more time looking to the grasping movement to the old object at the new position at test. The focus on the biological movement would represent a simpler processing of the event that did not include the additional component of goal-directedness.

Saliva cortisol concentrations as well as parental ratings indicated higher stress levels of infants in the stress condition than in the control condition after stress induction. Hence, stress manipulation was successful. We did not find a significant difference in looking behavior at test as a function of condition (stress, control). Across conditions infants looked longer to the test trials showing a hand grasping the new object at the old location, indicating that they had habituated to the goal of the grasping movement and thereby showed an understanding of the goal of the actor. Additionally, a longer accumulated looking time during the habituation phase for the infants under stress compared to non-stressed infants was observed.

These results suggest that acute stress does not influence infants' interpretation of actions as goal-directed. Nevertheless, the slower habituation speed for stressed infants indicates that it might have been more difficult for them to identify the action goal. The specificity and robustness of this effect could be the topic of future studies on stress-related social cognition in infants.

P1-G-138 - Maternal depressive symptom trajectories and early childhood inhibitory control development

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Details

Research into the relationship between maternal depressive symptoms and early childhood inhibitory control (IC) most commonly finds no association within the first 4 years of life (e.g., Power et al., 2021), however the field is limited by the available measures of IC, which often place demands on young children's cognitive abilities above and beyond this specific component of executive functioning. This

study assessed the relationship between trajectories of maternal depressive symptoms (MDS) and two measures of IC: a well validated parent-report measure and a new lab-based measure. The Behavior Rating Inventory of Executive Function - Preschool Version (BRIEF-P) (Gioia et al., 2003) was completed by a parent (primarily mothers) when the child was 36 and 42 months of age. The 'Inhibitory Self-Control Index' (ISCI) is used in this study as a parent-reported measure of IC – an alternative approach to the lab-based ECITT. The Early Childhood Inhibitory Touchscreen Task (ECITT) has been validated for use from 10 months of age to late adulthood (Hendry et al., 2022; Holmboe et al., 2021), and was administered to children in a testing session at 10, 16 and 42 months of age. Mothers completed the Beck Depression Inventory, Second Edition (BDI-II) (Beck et al., 1996) when their child was 10, 16, 24, 30, 36 and 42 months of age. Latent growth mixture modelling was used to group these mothers into categories based on their BDI-II score trajectories. One class, containing the majority of the mothers (n = 154), had a low BDI-II score that remained constant over time (low MDS). The smaller class (n = 16) had high BDI-II scores from the outset that showed a slight decrease over time (high MDS) (see Figure 1). Linear mixed effects models were used to analyze the effect of MDS group on child ECITT performance and ISCI score. The model with MDS group and age as the between- and within-subjects factors, and ISCI T score as the dependent variable, found a significant main effect of child's age on ISCI T score, showing an increase between 36 and 42 months of age. No significant main effect of MDS group or an interaction between MDS group and age was found. When the ECITT was the dependent variable in the model, a significant main effect of age, and a significant interaction between MDS group and age, were found. Post-hoc analyses revealed that the main effect of age was driven by a significant increase in ECITT scores between 16 and 42 months. The interaction between MDS group and age is demonstrated in Figure 2. The children in the low MDS group demonstrated a typical improvement in score over time. In contrast, children in the high MDS group showed no significant change over time, and, surprisingly, their scores were significantly higher than the low MDS group at the 10 month time point. Making inhibitory errors may be a key feature of typical infant IC development, and these results may indicate that this stage is less typical in children of depressed mothers.

P1-G-139 - Uncovering the influence of milk-derived exosomal microRNA on white matter development: A pilot study

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Details

Human milk is the preferred nutrition during infancy, and is thought to play a major role in supporting the dramatic neurodevelopment that occurs during this time. Differences in WM development are evident between human milk and formula fed infants[1,2], suggesting milk components not found in formula may impact WM development specifically, yet the underlying mechanisms remain elusive. MicroRNA (miRNA) has been shown to influence development of the cells that myelinate the WM bundles in the brain, and are delivered in milk through extracellular vesicles (hmEVs), which constitute up to 20% of milk volume[3], but are not found in formula. In this study we aimed to assess associations between WM development in exclusively milk fed infants and miRNA content across lactation, with the ultimate goal of optimizing human milk alternatives for best infant outcomes. A multi-level experimental design that included milk sample collection and non-sedated sleep MRI scans was applied. Mothers

were recruited from Carilion Roanoke Memorial Hospital, and were included if they intended to exclusively breastfeed for the first 3 months of the infant's life, and were excluded if any substances were used during pregnancy or study participation. The study enrolled 6 mother-infant dyads prenatally or up to 3 days post birth and all delivered full term. The dyads were followed until the infant was 3 months old. Milk samples were collected 1-3 days post birth (colostrum), 7-10 post birth (transitional), and 3 months post birth (mature). Exosome isolation was performed within 24 hours of milk sample collection. Structural and diffusion MRI was collected during non-sedated sleep at two timepoints, 2 weeks and 3 months. Data analysis utilizing mixed effects models is ongoing. Methods for miRNA analyses include RNASeq and qPCR (miR-92, miR-199, miR-148, miR-145, miR-17, and Let-7), hmEVs were assessed using electron microscopy Western blots, and MRI data are being processed using infant specific structural pipelines and QSIPrep[4]. The qPCR results demonstrate increased levels of these specific miRNAs between colostrum and mature milk (Fig. 1). The preliminary results support miRNAs are critical for WM development in infants. With further analysis of MRI data, we hope to gain insight into the amount and rate of growth across the first 3 months of life to determine the impact of miRNA on WM development. Research studies consistently converge on milk being ideal for infant development, but the specific mechanisms have been difficult to identify. The results of this study will aid conclusions about which mechanisms in milk support infant neurodevelopment to further assist the development of optimal human milk alternatives, ultimately leading to health improvement across the entire lifespan.

P1-G-140 - Sleep and language: How do sleeping behaviors influence linguistic outcomes of infants at different ages?

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Details

Sleep plays a crucial role in supporting cognitive development from early in life. Recent studies have shown the importance of sleep for memory (Friedrich et al., 2020), language development (Knowland et al., 2022), and executive functions (Gliga et al., 2023). However, sleep patterns drastically change in the first year of life, and the links between cognitive development and sleep routines (i.e., day and night sleep) at different ages remain uncertain.
Our preliminary study adds to this research line by exploring the role of night and day sleep in language development and how different sleeping behaviors might be associated with different linguistic outcomes at different ages. Fifty children were involved in the study. They were then divided into three groups, based on the expected linguistic milestones for that age, namely babbling, first words, and vocabulary explosion: group 1 between 6 and 9 months (n=15, Mage=7.4, SD=0.98), group 2 between 10 and 14 (n=19, M age =12.21, SD=1.36), and group 3 15 to 23 (n=16, Mage =17.38, SD=1.99). Sleep measures (night sleep duration and efficiency, nap number and duration) were retrieved from the use of an actigraph (MotionWatch 8) and a sleep diary filled by the infants' parents for three consecutive days. Language-related measures were collected using the LENA device (for Child Vocalization Count per minute - CVC/min) and the Italian version of the MacArthur-Bates Communicative Development Inventories (MB-CDI, Caselli et al., 2015; for expressive and receptive vocabulary, phonological abilities, and gesture production). Moreover, infants were classified as good and bad sleepers based on their

night sleep duration, number of night awakenings, and the efficiency of their sleep (similarly to Nunes et al., 2012); and on their day sleep i.e., the presence of naps throughout the day (nappers vs. non-nappers).
Our preliminary results show, in the babbling group, a significant and positive correlation between night sleep duration and children's receptive vocabulary (p=.008) and a negative and strong correlation between the number of naps and gesture production (p=.006).
For older children, differences in day but not night sleep routines seem to determine different linguistic and communicative outcomes. In group 2, significant differences emerged between nappers and non-nappers (favoring nappers) in expressive vocabulary (p=.042), phonological abilities (p=.05), gestures (p=.037), and CVC/min (p=.026). In addition, the number of naps negatively correlated with infants' receptive vocabulary (p=.020) and gesture production (p=.013). For group 3, a significant, strong, positive correlation between nap duration and infants' expressive abilities (p=0.006) was observed.
Our preliminary results suggest that night sleep behaviors play a crucial role in developing language comprehension skills mainly in the babbling group. Differences in day sleep routines seem to determine different linguistic and communicative outcomes in all the groups. Notably, more frequent naps are associated with less mature communicative skills; this might be because infants who nap more might get fewer opportunities to interact with others and broaden their vocabulary. Future studies should investigate whether there is a difference between nappers and non-nappers in the amount of linguistic stimulation they receive.

P1-G-141 - The role of the lexicon and inductive biases in the representation of abstract relational concepts.

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Details

Analogical reasoning is the capacity to reason about abstract relations. The Relational Match-to-Sample task (RMTS) was designed to test this ability (Premack, 1983), asking participants to match pairs of stimuli that exemplify the same relation; e.g., *AA* should be matched to *BB* as both exemplify the relation same; *AB* should be matched to *DE*, as both exemplify the relation different. Non-human animals and children younger than 5 typically fail this task (Hochmann et al., 2017). However, they succeed in other abstract matching tasks (e.g. number matching task) and in other relational tasks such as the same/different discrimination task, where they need to respond differently to same and different pairs, suggesting they do possess some representation of the abstract relations same and different.

Two accounts have been offered for these results. First, the infant/animal representations of same and different may not afford success in RMTS, and novel representations must be acquired around the age of 4 to enable analogical reasoning (Hochmann, 2022). Second, young children may fail at RMTS, not because they lack the proper representations, but because they exhibit an object bias that prevents them from considering relational hypotheses when trying to solve the RMTS (Kroupin & Carey, 2022). The second hypothesis predicts that modifying the inductive bias in favour of relational hypotheses should improve

performance in RMTS, even in younger children. The representational hypothesis, in contrast, predicts that modifications of inductive biases should only be effective after the representational change.

In Experiment 1, we first replicated previous findings showing that 3 and 4-year-olds fail at RMTS, while 5- and 6-year-olds succeed (N=24 per age group). In Experiment 2, 3-, 4-, 5- and 6-year-olds (N=24 per age group) were tested on the RMTS after taking a same/different discrimination task aimed at priming the representations of the relations same and different. Results showed that all age groups succeeded at the discrimination task. Four- to six-year-olds succeeded at the RMTS, while 3-year-olds still failed (Figure 1). Moreover, in both experiments, we observed a strong association between knowing the words "same" and "different" (as testified by children's spontaneous or elicited production of the words at the end of the experimental session), and success in RMTS.

Finally, doubling the sample size of the 4-year-olds tested in Experiment 2, we analysed children who produced the words "same" and "different" (N=25) and those who do not (N=23), separately. Again, both groups succeeded on the discrimination tasks, but only the group that produced the words succeeded at the RMTS. Moreover, in the latter group only, we observed a positive correlation between performance in the discrimination task and performance in the RMTS (Figure 2).

Overall, results suggest that a modification of inductive biases in favour of relational hypotheses is only effective in children that possess the words "same" and "different". Thus, differences in inductive biases alone do not account for the development of analogical reasoning. Rather, a representational change signalled (and possibly caused) by the acquisition of the words "same" and "different" appears necessary.

P1-G-142 - Parental autonomy support and trajectories of child cool and hot executive functions during toddlerhood: A biparental approach

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Details

Background and Aims: Executive functions (EF) are higher-order cognitive skills that are crucial for children's socio-emotional and academic adjustment (Diamond, 2013). EF have both 'cool' and 'hot' components (Zelazo & Carlson, 2012). Cool components are involved in neutral, abstract and decontextualized problem situations, while hot components are elicited under affective or motivationally salient situations. A growing body of research supports the role of parenting behaviors that encourage children's independent problem solving (i.e., parental autonomy support; AS) in the development of child EF (e.g., Matte-Gagné et al., 2015). However, while both maternal and paternal AS were found to be associated with better child EF (Matte-Gagné et al., 2015; Meuwissen et al., 2018), the unique contribution of each parents' AS remains to be identified, as research in this domain has yet to consider both parents' AS simultaneously. The present longitudinal study aimed to examine the unique contributions of both paternal and maternal AS in the developmental trajectories of cool and hot EF during toddlerhood.

Methods: 226 mother-father-infant triads took part in two home visits, around 13 months (T1), 19 months (T2), and 27 months (T3). Paternal and maternal AS were rated at T1 using a well-validated coding scheme (Whipple et al., 2011), applied to a 5-minute father-infant and mother-infant problem-solving sequence. At all time points, child EF was measured using three tasks: the Prohibition task (Friedman et al., 2011) involving hot EF, and the Hide and Seek (Garon et al., 2014) and Reverse Categorization (Carlson et al., 2004) tasks targeting cool EF (scores on both tasks were summed to compute a total score of cool EF).

Results: Descriptive and correlational analyses were first performed (see Table 1). To describe and predict intraindividual patterns of change in child hot and cool EF across toddlerhood, growth curves were fitted in Mplus using a multilevel modeling (MLM) framework (see Table 2). Results reveal significant growth in child cool and hot EF across toddlerhood. Paternal AS, not maternal AS, was found to be associated with child initial performance on the hot EF task ($\gamma_{01} = 1.82$, $p < .05$). Paternal AS was also linked to the rate of change in child hot EF ($\gamma_{11} = 0.31$, $p < .05$). Thus, higher levels of paternal AS were associated with higher initial levels of hot EF and greater growth in this EF component across toddlerhood. Concerning cool EF, maternal AS, but not paternal AS, was found to be predictive of the initial level ($\gamma_{02} = 0.95$, $p < .05$). However, this predictive effect attenuated across time, as reflected in the negative association between maternal AS and the rate of change in cool EF ($\gamma_{12} = -0.12$, $p < .05$).

Conclusion: The present study highlights the unique and differential roles of paternal and maternal AS in the development of child hot and cool EF during toddlerhood. It also underscores the importance of distinguishing the cool and hot dimensions of EF. Results will be discussed in light of the relevant literature.

P1-G-143 - Subcortical volume development in preterm infants and fetuses in the third trimester

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Details

Advances in neonatal intensive care have increased the survival rates for preterm-born infants over the last two decades (Mactier et al., 2020), yet morbidity has remained unchanged. Preterm birth is associated with a higher risk of cognitive, language, sensory and motor deficits. It also increases risk of neurodevelopmental disorders such as attention-deficit/hyperactivity and autism spectrum disorders, as well as mental health disorders such as anxiety and depression (Chung et al., 2020). By understanding how the preterm-born brain develops, support systems can be put in place to ensure optimal outcomes for these babies. An understanding of how the preterm brain differs from that of healthy fetuses can help inform us of the neural bases of these risks. The current study aimed to compare the growth of subcortical brain structures in healthy fetuses with babies born preterm. 47 women with singleton pregnancies in the third trimester were scanned longitudinally using MRI at least 2 weeks apart. Second time-point data were available for 39 women, for a total of 86 scans (postmenstrual age M=32.67, SD=3.34, range = 26.9-39.3 weeks). Preterm data comprised 85 datasets from the Developing Human Connectome Project (postmenstrual age M = 33.44, SD = 2.40, range = 26.71-36.86 weeks). Subcortical

volumes were segmented using validated semi-automatic and automatic methods (Wang et al., 2022; Zöllei et al., 2020; Figure 1). Individual linear mixed effects models examining the effect of age and group were conducted for left and right volumes in the amygdala, putamen, caudate, hippocampus, cerebellum, and thalamus, and were controlled for sex and total cerebral volume. After correcting for multiple comparisons, results showed significant interactions between group and age in both hemispheres in all regions (Figure 2). Additionally, the volumes of the hippocampus and cerebellum both exhibited quadratic relationships with scan age only in the preterm sample, indicating that volumes followed an exponential shape in this group, with the slope rapidly increasing in later ages. In all regions, the volumes in preterm infants were initially smaller than those in fetuses, but showed a steeper increase resulting in larger volumes at later ages. The differing trajectories between subcortical regions in preterm infants compared to fetuses may be explained by early exposure to the extrauterine environment, differing sensitivities to clinical care, *in utero* factors leading to preterm birth, or a combination of these factors.

P1-G-144 - Infants' conceptualization of inert agents

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Details

Like adults, infants are very good at detecting agents: They readily ascribe agency to novel entities that provide enough evidence that they can detect their environment and have internal control over their responses. Research has shown that cues of self-propulsion (e.g., initiate movements, change directions, resist external forces) alone are not sufficient for infants to attribute agency to a novel entity (Baillargeon et al., 2016). Here, in three violation-of-expectation experiments (N=96), we showed that self-propulsion is also not a necessary cue for agency.

Adults and infants expect agents to act consistently with their mental states. For example, when infants are presented with an agent who invariably chooses toyA over toyB, infants attribute a preference for A to the agent and expect the agent to choose A again in the future (Woodward 1998, 1999). In Exps1-2, we examined whether infants would perceive a novel entity as an agent and ascribe preferences to it in the absence of any self-propulsion cues. 13-month-olds first saw a novel, inert box "conversing" with a human experimenter to suggest that it's an agent (Beier & Carey, 2014). Next, when presented with a ball and a block, the box invariably beeped to the ball, communicating a preference for the ball over the block. In the test trials, we switched the locations of the ball and the block, and the box either beeped at the ball or the block. Here, infants expected the box to beep at the ball and looked significantly longer when the box beeped at the block. This suggests that infants perceived the novel entity as an agent despite the absence of self-propulsion, ascribed a toy preference to the agent, and expected the agent to act on this preference. Infants' expectations went away when there was not enough information to ascribe a toy preference to the box (Biro et al, 2011).

In Exp3, we asked whether infants assume that all agents are capable of self-propulsion, even when the agents never give prior evidence of self-propulsion. Here, 13-month-olds were presented with the same box. In the first familiarization trial, half of the infants saw the box sitting still and half saw the box

moving back and forth on its own (inert and self-propelled conditions). As before, infants in both conditions then watched the box converse with a human experimenter. In the test trial, infants saw an experimenter's hand lift the box and release it mid-air; the box remained afloat unsupported. Infants in the inert condition looked significantly longer at the test trial than infants in the self-propelled condition. This outcome adds to evidence that infants do not find it unexpected when self-propelled entities that can move back and forth independently can also resist gravity (Luo et al., 2009). Importantly, it provides new evidence that infants do not assume all agents to be self-propelled. Together, this data suggests that infants' conceptualization of agency is distinct and independent from their conceptualization of self-propulsion: A self-propelled entity is not necessarily agentive, and an agent is not necessarily self-propelled.

P1-G-145 - Temporal binding of audiovisual emotional faces in 9-month-old infants and adults: A brain connectivity study

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Details

In everyday interactions the temporal binding of facial visual cues with voices cues enables us to understand other people's thoughts, actions (Hyde et al., 2016) and emotions (Collignon et al., 2008). Indeed, redundancy across synchronous facial and vocal cues facilitate the detection of emotional signals in both 4-months infants and adults (Bahrick et al., 2019). However, few studies investigated time-varying functional connectivity of temporal binding integration comparing emotional and neutral stimuli in infants, and its developments trends. The present study aimed to investigate time-varying functional connectivity in response to audiovisual emotional faces in adults and 9-month-old infants. Adults (N = 34; mean age = 22.5 years, SD = 3.53) and infants (N = 13; mean age = 9 months 35 days, SD = 18 days - data collection is still ongoing for the infant sample) were presented with short videos (3480 ms) of actresses crying (negative emotion), laughing (positive emotion) or coughing (neutral). Stimuli were presented either synchronously or with the audio anticipated. To delve into the interconnections between brain areas involved in the integration of complex socio-emotional information, we applied age-appropriate templates (O'Reilly et al., 2021) and source-reconstructed EEG activity through a minimum norm estimate inverse solution. We then extracted the instantaneous phase, every 5 ms, between sources time series. On such data we computed the Phase Locking Value, a measure indexing the phase alignment between two signals. We then computed Minimum Spanning Trees (MST) for each time point (Stam et al., 2014). On trees we computed the eigenvector centrality, a measure identifying nets of highly interconnected nodes. To investigate the brain mechanisms involved in the binding of stimuli we applied permutation testing comparing asynchronous and synchronous stimuli. We then proceed with the same method to test functional networks' configurations in response to emotional categories. Our results with adults show, across frequency bands, the presence of feed-forward and feed-back mechanisms underlying the integration of intersensory social stimuli. Specifically, we observed that, starting from sensory areas, information travels to higher-order associative cortices (i.e., superior temporal sulcus and inferior frontal gyrus) and back to sensory areas. Regarding activity in response to emotional synchronous stimuli compared to neutral stimuli in adults, we observe increased processing of negative compared to positive emotions (e.g., Zhao et al., 2019), indeed, areas involved in

the processing of crying are more numerous across frequency bands. The preliminary and qualitative investigation of sources in infants shows a similar pattern of information flow, thus possibly confirming the presence of a feed-forward and feed-back loop comprising sensory and associative regions and underlying a possible increased processing of negative compared to positive emotions. We propose these mechanisms to be involved in the building of coherent and informed percepts of the complex world surrounding us. Once our infant sample will be completed, we plan to apply the same pipeline as in adults, this will provide further insights into the mechanisms that bind sensory stimuli together even in early infancy, and whether and how they are shaped by emotional information.

P1-G-146 - Investigating audiovisual spatial integration in infancy

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Details

Spatial representations empower us to engage with our surrounding environment and are constructed in adults by integrating spatial cues across our senses. In this poster, we will report the findings of an experiment investigating the spatial parameters of audiovisual integration in human infants aged 1-3 years. Specifically, we probed the horizontal spatial disparities at which infants perceived auditory and visual cues as being integrated (a single source) or separate (two sources). We presented infants with a series of trials comprising: i) pairs of auditory stimuli (auditory pairs; “AA”), ii) pairs of visual stimuli (visual pairs; “VV”), or iii) audio-visual pairs (“AV”). At the beginning of each trial, the two stimuli (whether AA, VV, or AV) were presented in the same position, centred on the infants’ midlines. Over 13 seconds the two stimuli were then gradually moved apart in opposite directions in the horizontal axis, at a constant speed. For each trial, we assessed the time it took (reaction time in ms) for infants to first move their eyes between two locations indicating a spatial segregation of the two stimuli. The stimuli were presented via two smartphones positioned on two small independent trolleys attached to horizontal tracks. The auditory stimuli consisted of pink noise and a “beep” sound emitted by the smartphones’ speakers. The visual stimuli consisted of an LED flash emitted by the smartphones. Auditory and visual stimuli lasted for 13 seconds. The experimenter sat behind the stimulus array controlling the movements of the stimuli, and the infants sat facing the device The mean and standard deviation of RTs across conditions from a preliminary sample of n=3 infants (Mean Age =20 months SD= 13.8 months) are presented in Figs. 1 and 2. A one-way non-parametric Kruskal-Wallis ANOVA compared reaction times across Condition (AA, VV, AV), within-subjects. We found no difference between conditions (χ^2 = 2.76, (df = 2), p-value = 0.25). Likewise, the Kruskal-Wallis ANOVA on the standard deviation revealed no difference among conditions (χ^2 = 0.62, (df = 2), p-value = 0.73). To verify for multisensory integration, we also computed the Maximum Likelihood Estimation (MLE) prediction for the RT variability in the audio-visual condition, and we compared the prediction with the observed audio-visual stimuli variability. Although no significant difference was found between predicted and observed data (p-value = 0.25), suggesting a possible multisensory integration, our preliminary data (Figs. 1 & 2) indicate that the infants showed shorter reaction times in the VV conditions, suggesting that the infants show an earlier perception of separate stimulus sources in this condition. We speculate on the basis of these preliminary data that visual information may be favored relative to multisensory integration for object segregation in infants (Neil et al. 2006; Lawson, 1980) possibly because of the greater reliability of visual than auditory cues to location.

We anticipate that this new means of investigating the multisensory segregation of objects opens the way for further exploration of the multisensory spatial representations in early life.

P1-G-147 - Development of sense of agency in infancy

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Details

Our sense of agency, the sensation of controlling our actions and thereby influencing events in the external world, is a fundamental aspect of human self-awareness. Previous adult studies suggest that sense of agency arises from comparing a predicted state, derived from intentions and motor commands, with the actual perceived state. However, when and how this internal model and sense of agency principles develop remain unclear. Some researchers propose that the sense of agency is present shortly after birth. For example, 2-month-old infants demonstrate increased responses (like kicking, sucking) when their actions modify external events, unlike when they correlate with random events (Rovee & Rovee, 1969; Watson, 1972; Rochat & Striano, 1999). Yet, recent studies indicate that the capacity to predict the consequences of one's actions, vital for the sense of agency as per the comparator model, does not emerge until 6 to 8 months of age (Paulus et al., 2012; Gerson, Bekkering & Hunnius, 2015; Gerson et al., 2015). Therefore, it might be more straightforward to attribute early behaviors, like increased response to events contingent on bodily movements, to basic sensory learning of visual-proprioceptive contingencies rather than to a sense of agency stemming from comparing intended and actual action outcomes. In this study, we explore a new experimental paradigm using gaze-contingent techniques. During the experiment, a cartoon character is displayed on the screen where the infant looks and follows their gaze movement. To manipulate control through eye movements, we introduce two delay conditions (0s and 1s) for the character's response to eye movements, and one condition where the character follows another person's gaze. This task allows us to examine whether infants' eye movements are voluntary active exploration or mostly stimulated by external sensory input by distinguishing the tracing movements on the cartoon character from actively moving the cartoon character via their eye movements. Voluntary active exploration leads to more eye movements that move away from the cartoon character; external simulated behaviors are linked with eye movements moving towards the cartoon character. We predict that the 0s delay condition, which is likely to promote a sense of agency, will result in more explorative eye movements, while the delayed and other person gazing conditions are likely to show more tracing eye movements. We also predict that the explorative eye movements in the 1s delayed condition will gradually increase along with age because infants are more likely to develop a sense of agency for slightly delayed sensory input during development. The data collection targeting 4 to 24-month-old infant is ongoing and we plan to present the complete results at the conference.

P1-G-148 - Maternal sensitivity in infancy and academic achievement in elementary school: A longitudinal study

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Details

In this study we investigate the longitudinal impact of maternal sensitivity on performance in a school setting. Parental sensitivity is a key aspect of parenting behavior and includes perceiving, interpreting and adequately responding to a child's signals in a timely manner (Ainsworth, 1973). The quality of parental sensitivity in infancy and beyond has been found to have lasting effects on a variety of different developmental outcomes, including language learning (Bornstein et al., 2020), self-regulation (Bernier et al., 2010) and academic achievement (Fraley et al., 2015). Much of this research is concerned with short-term relations only. The current study is expanding upon these findings by assessing the long-term impact maternal sensitivity in infancy on academic achievement in elementary school in a German sample.

To measure maternal sensitivity, mothers and children were videotaped during a 5-minute long free play session in a lab setting with a set of age-appropriate toys. The Emotional Availability Scales (EAS) were used to score sensitivity, structuring, non-intrusiveness and non-hostility of the mother and responsiveness and involvement of the child (Biringen, 2008) when the children were 12 months old. Academic achievement was measured by retrospectively assessing the children's final elementary school grades via questionnaire in adolescence. Data from 145 German low-risk mother-child dyads during the first time point are available. Data collection of the school grades is still on-going, with over 70 dyads having been assessed so far.

We expect children whose mothers displayed higher degrees of sensitive behavior at 12 months of age to achieve higher grades at the end of elementary school. This research might provide some insights into how the gains from sensitive parenting can translate into positive outcomes in a school setting.

P1-G-149 - Infants attribute ordering propensity to agents that built an efficient artefact

Eszter Kortvelyesi [1], **Erno Teglas** [1]

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Details

The presence of an ordered array is diagnostic of the presence of intentional design not only for adults but also for children. This has been confirmed by two distinct lines of studies. First, there is evidence suggesting that the past presence of an agent can be inferred from changes caused in the environment early in development[ET1] [EK2] (Friedman, 2001). Even 12-month-olds expect human hands to create an ordered array (Newman et al., 2010), but show surprise when a mechanical object does so (Ma & Xu, 2013). Second, ordered arrays may take the form of an artefact, as the elements of the artefact's structure follow a plan created by its designer. Past research [ET3] has shown that adults and children prefer to take the perspective of the 'design stance' to evaluate artefacts. From at least six years of age children categorize and judge the function of an artefact based on the function intended by the original designer (Kelemen & Carey, 2006). Even when that design if highly inefficient (e.g., causes fatal accidents) adults judge its function to be the one intended by the designer (Chaigneau, Castillo, &

Martínez, 2008). In this study we hypothesized that the creation of order and the creation of an artefact stem from the same ontological root and signal the competence of an intentional agent that can create a non-random structure. First, in an interactive demonstration phase an experimenter revealed to 14-month-old infants how to assemble an efficient rake. The participants that tried to assemble the rake themselves then participated in a looking time experiment in the lab. Our violation-of-expectation paradigm tested whether infants develop an expectation that a novel agent creates order from disorder after seeing this agent repeatedly build an efficient rake. The test scene where the agent created disorder, elicited longer looking times in contrast to the scene where it created order (i.e. transformed an initial random layout of an object array into an ordered arrangement according to the Gestalt principles of proximity), suggesting that for our participants, the tool-building behavior was compatible with the creation of order but was not compatible with the creation of disorder. This looking-time pattern, which was dominant at the beginning of the test phase, disappeared over the course of the subsequent test trials: participants quickly accepted not only order but also disorder as a possible outcome of an intentional agent's actions.
These results show that infants consider the creation of non-random structures as a competence that generalizes from tool creation to a more abstract capacity of order creation, without depriving the agent of the freedom to create disorder.

P1-G-150 - Associations between lead risk exposure and neural function in infancy

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Details

The effects of lead exposure on children's outcomes have been well-documented and have shown to include deficits in several domains of development. As early as the prenatal period, lead exposure has been associated with poorer outcomes related to early cognitive development. Though some work has examined childhood lead exposure in relation to brain structure both concurrently and in adults, less work has examined how lead exposure might impact brain function during infancy. A better understanding of how lead might be associated with neural function as early as infancy might have implications for the development of prevention and intervention strategies. To this end, we will examine how lead exposure risk might be associated with brain function during the first year of life in a cohort of approximately 100 infants (n=54 longitudinal) from the New York City metropolitan area. Analyses will examine whether lead exposure risk would be associated with resting EEG power at 1-month of age and 9-month of age, and whether lead exposure risk would be associated with changes in resting EEG power between 1- and 9-months of age. Lead exposure risk will be measured using participant address data and publicly available data reporting on the presence of lead water pipes at the household level in New York City. Risk will be operationalized as the presence of lead pipes versus the absence of lead in pipes. We hypothesize that infants with lead exposure risk will show greater relative low-frequency power, and reduced relative high-frequency power, consistent with patterns observed in infants who grow up with fewer socioeconomic resources and higher psychosocial stress. Longitudinally, we hypothesize that infants with lead exposure risk will exhibit less change in relative high-frequency and low-frequency power, in contrast to the typically exhibited developmental trend of an increase of relative high-

frequency and decrease relative low-frequency power as infants age. Results will contribute to an ongoing body of research examining mechanisms through which lead exposure contributes to neurocognitive functioning in childhood and beyond.

P1-G-151 - Exploring the role of neurodevelopmental disability condition on maternal behavior and maternal mood states

Laura Cordolcini [1], **Annalisa Castagna** [2], **Eleonora Mascheroni** [3], **Elisa Rosa** [2], **Niccolò Butti** [2], **Rosario Montirosso** [2]

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Details

Neurodevelopmental disability (ND) comprises a wide variety of clinical conditions including infant cerebral palsy, genetic syndromes, metabolic diseases, and brain injuries (Montirosso et al., 2020). Infants with ND share high risk of impairment in several developmental domains (Shevell, 2009; Olusanya et al., 2018) with a consequent impact on maternal psychological and emotional well-being (Verhey and Kuper, 2019; Vameghi et al., 2016). To the best of our knowledge, little is still known about what specific maternal behaviors might be different in an ND parenting condition than in typical parenting.

The aim of the study was to observe maternal behaviors (emotional closeness, responsiveness, encouragement and teaching, and reported touch behaviors) and psychological experience (depression and anxiety) in mothers of infants and toddlers with ND.

26 infants and toddlers (14 females) with ND aged 0-3 years old and their mothers participated in the study. A control group of children with typical development (TD) (n = 26) and their mothers, matched for sex and infant's and mother's age, was recruited. For each dyad, a 10-minutes free play interaction was video-recorded for later coding using the Parenting Interactions with Children: Checklist of Observations Linked to Outcomes (PICCOLO; Roggman et al., 2013). Mothers were also asked to fill in some questionnaires: The Parent-Infant Caregiving Touch Scale (PICTS, italian version by Wigley et al., 2023); Beck Depression Inventory (BDI, italian version by Sica et al., 2007); and State and Trait Anxiety Inventory (STAI, Spielberg et al., 1971).

After adjusting for multiple testing, MANOVA results showed that mothers of infants and toddlers with ND behave differently than mothers of infants and toddlers with TD ($p < .001$). They exhibit a smaller number of responsive ($p = .002$), encouraging ($p < .001$) and teaching ($p = .001$) behaviors. Correlation analysis indicates that the more severe the ND (measured by Griffiths Scale of Child Development), the smaller the number of responsive, encouraging and teaching behaviors.

T-test analysis revealed that mothers in the ND group report less affective communication touch behaviors towards their children ($p = .003$) than mothers in the TD group. Correlation analysis revealed that the more severe the ND, the smaller the number of this kind of touch behaviors. Furthermore, mothers of infants and toddlers with ND report higher scores in BDI ($p = 0.21$) and STAI (state: $p < .001$, trait: $p = 0.14$) than mothers in the TD group. Moreover, some correlation emerged between maternal mood states and

parenting behavior: the higher the depressive and anxious scores, the smaller the number of encouraging and teaching behaviors.

This evidence suggests that ND motherhood could be characterized by less responsive, encouraging and teaching behaviors during mother-infant interaction, and by a smaller number of reported affective communication touch behaviors, showing that motherhood in the ND condition is more challenging than in the TD condition. This is also confirmed by our results that shows that mothers of children with ND experience more depressive and anxious symptoms.

P1-G-152 - Toddlers are swayed by the "big basket" in the Reverse Categorization task

Martha Ann Bell [1], **Leslie Patton** [1]

[1] Virginia Tech

Details

Executive functions are the focus of much early cognitive developmental research. Of all the executive functions, inhibitory control (IC) may be the most critical in early development because early IC shows strong predictive ability to later cognitive, academic, and socio-emotional outcomes in childhood (Blair & Razza, 2007; Carlson & Wang, 2007). A view of IC during early development, proposed by Diamond (2013), has two main types of inhibition: interference control and self-control/response inhibition. Response inhibition is foundational for developing self-regulation and is widely studied in early childhood, but we know little about their development prior to the 3rd birthday. We focused on the development of response inhibition during the second year, when developmental changes in multiple aspects of self-regulation are rapidly occurring (Blair, 2002).

Thirty-eight typically developing toddlers (half girls) and their parents were seen in the research lab at 15, 18, 21, and 24 months. At each lab visit we administered various toddler executive function tasks. Here we focus on a complex response inhibition task known as Reverse Categorization (Garon et al., 2008). The task is typically administered such that the toddler is shown big blocks and little blocks and is taught to sort them into a big basket and a little basket, respectively. After this initial sorting, the toddler is taught the “reverse” rule: big blocks go into the little basket and little blocks go into the big basket. The rule is repeated before each trial of the reversal phase and toddlers typically perform poorly because the reversal is considered to require complex response inhibition that may be beyond the current abilities of toddlers during the second year.

Rather than focus on total proportion correct in initial sorting and reversal sorting, we examined the sorting of big blocks and little blocks separately. For the initial sorting (big blocks in big basket, little blocks in little basket), there was a main effect of block size (Wilks’=.52, p=.02) and a trend interaction of block size X age (Wilks’=.32, p=.06). As seen in Figure 1, toddlers improved in sorting little blocks into the little basket across age, but consistently performed well on big blocks into the big basket. For the reverse sorting (big blocks in little basket, little blocks in big basket), toddlers showed little improvement across age in sorting either size block, but showed much better performance in sorting little blocks into the big basket. Thus, for both the initial sorting and the reversal sorting, whatever was sorted into the big basket was more likely to be correctly sorted compared to whatever was sorted into the little basket.

The pattern of toddlers' performance on this complex response inhibition task raises questions about its utility as a response inhibition task. Indeed, it is considered valid beginning at 24 months and yet the 24-mo-olds in our study showed the same big basket bias as then had when younger. It may be that because the task is so complex, toddlers are making new rules and playing their own game when doing Reverse Categorization.

P1-G-153 - Does perinatal maternal stress predict the development of young children's executive functions

Leah Gano [1], **Jeffrey Measelle** [1], **Jennifer Ablow** [1]

[1] University of Oregon

Details

Introduction: Previous research has established that maternal perinatal stress is associated with both positive and negative socioemotional outcomes early in life. At present, however, much less work has examined how conditions of stress during and following pregnancy anticipate early cognitive development, in particular, child executive functions. Executive functions (EF), with specific domains of temperament operating as developmental precursors to EF, encompass three major cognitive processes: inhibitory control, working memory, and cognitive flexibility. EFs have been shown to predict school readiness and school success, rendering it critical that infancy be explored as a crucial time for these cognitive processes to develop. This study aimed to elucidate the ways in which mothers' perinatal stress first predicted infant regulatory and attentional processes at 5 and 18 months, and subsequently, children's EF at 60-months postpartum.

Method: Drawn from a larger longitudinal study of families living at or below the US poverty line, pregnant women (N = 105) were assessed for prenatal stress using the Recent Life Events questionnaire, Beck Anxiety Inventory, and Center for Epidemiologic Studies Depression (CES-D) Scale. Postnatal maternal stress was assessed at 5- and 18- and 60-months postpartum using the same stress measures as well as the Parenting Stress Inventory. All stress measures were composited into a single factor score, which demonstrated reasonable internal consistency at each time point (M Cronbach alpha = .83, .73-.87). At 5 months, infant temperament was assessed with the Infant Behavior Questionnaire, of which only the Orienting/Regulation factor (comprising Duration of Orienting and Low-intensity Pleasure subscales) was used in the present study. At 18 months, temperament was assessed with the Early Childhood Behavior Questionnaire, but here too, only the Effortful Control factor (comprising Inhibitory Control, Attention Shifting, Low-intensity Pleasure, Cuddliness, and Attention Focusing subscales) was used. At 60-months (age five), children were tested on a battery of executive functions tasks. These tasks included a delay of gratification task, the Snow/Grass Stroop Task, the Day/Night Stroop Task, the Dimensional Change Card Sort Task, Stanford Binet Intelligence Scale, the NEPSY Visual Attention Task, and the Tower of Hanoi Task. Although each domain will be analyzed separately, an EF composite was also created by forcing a single factor solution (Cronbach alpha = .791). In our central analyses, family income, race, and child sex served as controls.

Results: Initial multiple regression analyses, in which mothers' postnatal stress factor was also entered, reveal that higher prenatal stress significantly predicted infants' lower EF precursor at both 5- (ß = -.11, t

= 2.52, p = .036) and 18-months (ß = -.14, t = 3.68, p = .025). Women's postnatal stress factor did not predict EF at 5 months but did at 18-months (ß = -.08, t = 2.11, p = .054). These results will be discussed in terms of the possible fetal programming effects of prenatal stress, which appear compounded by postnatal stress. Fuller analyses are underway to determine how perinatal stress predicts actual EF at 5 years postpartum.

P1-G-154 - Influence of parental cognition on infant cognition in neurodevelopmental disorders

Lindsay Mullin [1], **Tessa G. Buscher** [1], **Kelly Botteron** [2], **Stephen Dager** [3], **Annette Estes** [4], **Natasha Marrus** [5], **Juhi Pandey** [6], **Robert Schultz** [7], **Tanya St. John** [4], **Mark Shen** [8], **John Constantino**, **Joseph Piven** [8], **Heather Hazlett** [8], **Jessica Girault** [9]

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Details

Background: Genetic background impacts phenotypic variation in neurodevelopmental disorders (NDDs), and recent evidence suggests that parental traits may help predict outcomes in children with both genetically defined (Finucane, 2016; Dyer-Friedman, 2002) and idiopathic NDDs (Lyall, 2014; Gardner, 2020). No studies to date have assessed the predictive utility of parental traits in NDDs in the first years of life when targeted, early interventions are likely to have the greatest positive impact. We address this gap by testing for associations between parental and infant cognitive scores in infants with FXS, infants at higher likelihood for ASD due to having an older sibling with ASD, who themselves develop (HL-positive) or do not develop (HL-negative) ASD, and infants with low likelihood for ASD (LL).

Methods: Infants were assessed at 6, 12, and 24 months of age with the Mullen Scales of Early Learning (MSEL; Mullen, 1995) or the Bayley Scales of Infant and Toddler Development (Bayley, 2019). Cognition in parents was measured by the Shipley Institute of Living Scale (Shipley, 2009). Pearson correlations assessed associations between parent and infant cognition at each timepoint. Group sizes were, FXS: 17 infants, 17 mothers, 9 fathers; HL-positive: 38 infants, 30 mothers, 22 fathers; HL-negative: 83 infants, 77 mothers, 36 fathers; LL: 83 infants, 78 mothers, 54 fathers.

Results: Parent scores did not differ between groups. Infant scores differed between groups at each timepoint such that FXS < HL-positive < HL-negative < LL (*p* values < .028). Parent scores were not associated with infant scores at 6 or 12 months in any group. At 24 months, maternal scores were positively correlated with FXS infant scores (r = .75, p = .02). At 24 months, paternal scores were positively correlated with infant scores for both HL-negative (n = 36, r = .33, p = .049) and HL-positive (n = 22, r = .51, p = .015) infants. We found no associations between paternal and infant scores in the FXS group, maternal and infant scores in either HL group, or any parental scores in the LL group.

Conclusions: Our results demonstrate that parental traits are associated with child cognitive abilities by age 2 in FXS and HL infants (regardless of ASD diagnosis) with patterns observed between groups that may parallel etiology. Mothers of FXS infants carried the FXS premutation; the observed correlation may indicate a relationship between the inheritance of FXS and of cognitive ability. While previous research has established higher rates of ASD in children of fathers with higher intelligence, we uncovered a positive association between paternal, but not maternal, cognition and infant cognition in families where an older sibling has ASD. These findings suggest that easier-to-collect parental cognitive assessments may help identify infants who may later exhibit developmental delay. Future directions will examine potential parent-of-origin effects, or the impact of assortative mating on these results, and include infants with Down syndrome, allowing us to assess the predictive utility of parent cognition on infant cognition in additional NDDs.

P1-G-155 - 2-to 3-year-old toddlers differentiate the epistemic terms 'know' and 'think' in an eye-tracking paradigm

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Details

The acquisition of mental state language in the second and third years of life plays a crucial role in cognitive development. Current empirical research indicates a continuity from a preverbal representation of mental states in joint attention through the acquisition of mental state language to explicit theory of mind reasoning (Brooks & Meltzoff, 2015). By the age of 4 years, children master the distinction between the factive verb 'to know' and the non factive verb 'to think' in a choice task (Kristen-Antonow et al., 2019; Moore et al., 1989). Even 2-year-olds use 'know' and 'don't know' appropriately to refer to their own and others' epistemic states in spontaneous speech (Harris, Ronfard et al., 2017; Harris, Yang et al., 2017). However, to date, no systematic study has addressed 2- to 3-year-old children's comprehension of epistemic verbs.

In the present study, we used eye-tracking to measure gaze behavior as an indicator of an implicit understanding of the epistemic verbs 'know' and 'think' in 27- and 36-month-old children using a modified version of Moore et al. (1989)'s task. In this longitudinal study, toddlers (N = 199 at 27 months of age, N = 131 at 36 months of age), in the warm-up phase, participated in a hiding game, in which two agents expressed contrasting epistemic statements about the location (left vs. right box) of a hidden object ('I know it is in there' vs. 'I think it is in there'; see Figure 1) followed by the question of a narrator "Where is the sticker?" and the presentation of both boxes. In the experimental task, toddlers' understanding of epistemic state verbs was measured via preferential looking to the target (the box associated with the agent that knows) compared to the distractor (the box associated with the agent that thinks) in a pre- and post-questioning phase in eight trials, expecting a distinction in at least one of the phases. We computed the proportion of target looking time (PTL) for all phases: PTL = amount of fixations to target / amount of fixations to target to target + distractor (see Mani & Plunkett, 2007, 2008, for similar analyses) and fit linear mixed-effects models (Bates et al., 2015).

We found that toddlers both at 27 and 36 months of age showed a decrease in looking at the target from the pre- to the post-questioning phase. Further, results indicated a preference for 'know' over 'think' in the pre-questioning phase. After this reaction their preference switched in the post-questioning phase; however, the effect in the post-questioning phase was smaller (see Figure 2). Taken together, at both measurement points, children showed a distinction of epistemic terms, revealing the first empirical evidence that toddlers in their third year of life distinguish between 'know' and 'think' as indicated by their spontaneous gaze behavior.

P1-G-156 - Investigating infants' scene perception: The importance of actions

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Details

Little is known how infants acquire knowledge about real-world scenes and differentiate between scene categories. Previous studies have shown that that 15-month-olds are sensitive to object-scene inconsistencies (Duh & Wang, 2014) and that 18-month-old infants can categorize familiar scenes (Blesic et al., in prep). Here, we were interested whether action and scene knowledge are related in development. In particular, we investigated whether observation of actions affects scene recognition in infants.

We tested 18-month-olds (N = 25, M = 552.6 days, SD = 13.6 days) in a preferential looking task in which eye-gaze was measured with an eye tracker. The experiment consisted of 12 trials in which we first presented infants with background- and object-void videos of a person performing an action (e.g., eating), followed by the presentation of a target and distractor image from two different scene categories side by side. The target image represented the scene in which the action usually occurs (e.g., kitchen), whereas the distractor image represented the scene in which the action was less likely to occur (e.g., bedroom). Throughout the experiment, infants observed 6 different actions and 6 different scene categories. The scenes in the test phase were organized into three different pairs. We presented each of the pairs two times: once following the action related to one of the two test scenes and once after the action related to the other scene.

For each trial, we computed the ratio of looking at the target relative to looking at both scenes. We expected that if infants' scene recognition is primed by the preceding action, we should observe longer looking at the target scene at test. Infants looked significantly longer to the target scene at test (M = 0.54, SD = 0.07) compared to the chance level of 0.5 ($t(24) = 2.8044$, p = 0.01, 95% CI = [0.51, 0.57]).

Our findings suggest that infants' knowledge about actions may play a role in their representation of scenes. This is consistent with recent adult research showing the importance of action-related information in scene comprehension (Ciesielski, Webb & Spotorno, 2023). The present study extends these empirical findings by pointing to an early link between action- and scene perception suggesting that the acquisition of scene categories might also rely on action understanding.

P1-G-157 - Tracking action in XR mark test reveals developing body representation among toddlers

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Details

The mark test, developed by Gallup in 1970, is a classical test for evaluating self-recognition and has been studied extensively among various species over the past 50 years (Gallup, 1970). In this test, the participants discover, through their mirror images, a mark secretly placed on their faces that they spontaneously touch to remove. To date, the mark test has not been considered a test for assessing self-body representation because of its emphasis on the emergence of self-oriented behaviors.

However, we believe that we can clarify the developmental process of self-body representation by extending the mark test to a whole-body version and analyze the reaching movement for marks on various body parts. In this study, by integrating skeletal detection with OpenPose (Cao et al., 2021) and augmented reality technologies, virtual marks were displayed on 30 parts of the participants' bodies (named Bodytoypo; Fig. 1) and localization errors and hand movements were comprehensively analyzed.

A total of 36 Japanese children aged 2.5 to 3.5 years participated in the study. The final sample comprised 30 children (mean = 34.7 months, range: 28–44 months; 18 2.5-year-olds, and 12 3.5-year-olds). The mean number of executed trials were 27.50 and 29.75 for the 2- and 3-year-olds, respectively. The overall error rates for the first touch were 39.9% and 35.0% for the 2- and 3-year-olds, respectively ($t(28) = 1.098$, $p = .282$, *n.s.*, effect size $d = .398$).

Furthermore, using a statistics-based analysis of the hand movement of the first touch of the mark, we found several factors that predicted localization error. We divided the first touches in each trial into latency for observing the mark and reaching for localization of the mark (Fig. 2(A)), and examined factors that predicted mark localization errors. We found that latency predicted localization errors at age two ($F(30, 436) = 1.666$, $p = 0.016$). In incorrect trials, the latency tangle-gram for 2-year-olds was characterized by an association between the right upper and lower parts. In contrast, the predicted localization errors were reached at age three ($F(30, 308) = 1.636$, $p = .022$). The same body part association was observed for the reaching tangle-gram in 3-year-olds (Fig. 2(C)).

Finally, to determine the most informative inputs, we examined a linear mixed model fitted using the Akaike Information Criterion and found developmental changes in reaching strategies (Fig 2.(D)). A naive expectation would be that younger children would take longer to reach, whereas older children would be able to reach more quickly. However, the predictive model showed the opposite: Trials with shorter reaching durations predicted more touch errors at age two, whereas trials with longer reaching durations predicted more touch errors at age three. The results and video coding revealed three types of reaching strategies (ballistic search, feedback control, and feedforward control). In conclusion, Bodytoypo provides a new potential for classical mark tests and can be an effective method for evaluating self-body representation development.

P1-G-158 - Uncovering the neural underpinnings of early number word learning

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Details

Strong maths skills are not only important for success in school, but they are also essential for economic and occupational success later in life. Understanding the earliest markers of weaknesses in mathematics could have far-reaching effects as it could help identify children who have the greatest need for additional educational support. Acquiring the meaning of number words during preschool years is crucial as it lays the foundation for future maths learning. The Cardinality Principle (CP) states that the last number reached in a count list represents the size of the whole set. Children begin to learn the exact meaning of small numbers (e.g., two = **), by learning each number one-by-one until they eventually become CP-knowers. However, it remains unknown how different brain networks support the acquisition of the CP and if there is a developmental shift in the brain regions supporting children's number word processing. Knowing how different brain networks are involved in this conceptual shift is important, as this will help us gain a deeper understanding of the neurocognitive process supporting this developmental milestone. For the first time, we will investigate the conceptual changes in children's number word knowledge using functional near-infrared spectroscopy (fNIRS). Preliminary behavioural and neuroimaging data will be collected from preschoolers from the age of 2 in the North East of England to capture this crucial developmental window of children's number word learning. We will use a well-validated number task (Give-N-Task) to determine children's number-knower level (one-, two-, three-, four- and CP-knowers). Following this, children will wear an fNIRS cap while completing a passive version of a number word-quantity mapping task to compare brain activity across knower-levels to examine neurobiological differences in number word knowledge. We predict that children who know the count sequence but do not know the meaning of the words will use left inferior frontal and temporo-parietal language networks for counting. Once children understand the meaning of words, we predict that they will show a shift to bilateral intra-parietal numeracy networks in the brain. This will add significantly to the literature as no study to date has examined whether there might be a conceptual shift in the brain when children learn number words. Developing strong early numeracy skills is important, as they lay the foundation for future maths learning. Pilot data will be collected in the North East of England, an area where poor numeracy skills are prevalent compared to other regions in the UK. Using a multi-method approach that uses well-validated behavioural measures as well as novel neuroimaging techniques (fNIRS) will provide converging evidence about children's number word learning from both behavioural and neural perspectives. Further, examining number word learning in the North East of England, where children significantly lag behind their peers in the South, allows us to examine children's number word learning in a population that faces significant barriers in meeting early learning milestones. This proposed research, therefore, has both the potential to impact the development of interventions for early identification and uncover the neurobiological underpinnings of children's early numerical abilities. Data collection for this study will begin in the spring, and preliminary data will be presented at the conference.

P1-G-159 - Global-level categorization during infancy: frequency tagging EEG responses

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Details

Adults and infants form abstract categories of visual objects (Quinn & Johnson, 2000), and converging evidence indicates that infants form broader prior to more narrow categories (Mandler & McDonough, 1998; Pauen, 2002). However, only little is known so far about the development of underlying brain processes. Recently, we demonstrated very fast, high-level categorization of animals and furniture in infants employing frequency tagging in EEG (Peykarjou et al., 2023). This study aims to characterize the development of very fast global categorization (living and non-living objects), and to determine whether and how low-level stimulus characteristics contribute to this response.

We employed the Fast Periodic Visual Stimulation (FPVS; Rossion, 2015) approach to characterize the development of global-level categorization at four and seven months. We presented highly heterogeneous pictures of animate (humans, mammals, reptiles, insects, birds, and amphibiae) and inanimate (tools, buildings, electrical devices, kitchen utensils, furniture items, vehicles) visual objects while recording infants' electroencephalogram (EEG). This paradigm provides an implicit, objective, robust measure of visual categorization (de Heering & Rossion, 2015; Rossion et al., 2015), requiring both discrimination between categories and generalization across exemplars. *N* = 24 four-month-olds and *N* = 24 seven-month-olds were presented with original and phase-scrambled control sequences. During each 20-second sequence, 4 items of one category were presented consecutively, constituting the standard category. Every 5th stimulus belonged to the deviant category (AAAABAAAAB…). Base stimulation frequency *F* was 6 Hz (i.e., 6 images/second), and the response to category changes and harmonics (1.2 Hz; *F*/5; n*F*/5) was used to measure categorization.

Harmonics for summation of the categorization response were identified per age-group and were broadly distributed (four months: harmonics 2-14, seven months: harmonics 2-12). Summed responses revealed strong and significant ($Z > 2.33$, $p < .01$) categorization of original animate and inanimate deviant objects in the occipital region in both age-groups. Only at four months, scrambled inanimate objects also elicited categorization.

These data demonstrate high-level visual categorization of animate and inanimate objects across infancy, while sensitivity to low-level stimulus characteristics is evident only at four months. Recently, it has been demonstrated that infants also categorize animal and furniture items by four and seven months of age, but responses were narrower regarding the range of significant harmonics (Peykarjou et al., 2023). Thus, the current study provides evidence that infants are especially sensitive to broad categorical information, enabling them to form very broad predictions about visual objects and facilitating successful interactions with living and non-living objects.

P1-G-160 - The role of night and day sleep for children's language development: an exploratory longitudinal study.

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Details

Sleep plays a facilitating role in language acquisition and development (Howart et al., 2015), as it contributes to the consolidation of information soon after it is acquired. However, it is not still clear which specific sleep behaviors facilitate language learning and crucially, whether these behaviors can predict language development. Some studies focused on the relationship between fragmented night sleep and later language skills (Dearing et al., 2001), while others posited a major interest in the role of daily naps (Howart et al., 2016).

Our preliminary work tried to shed light on the contribution of night and day sleep behaviors on later children's language development. To do this, a group of 24 Italian infants (between 5 and 18 months) was involved in two phases: first (T1) infants' sleep behaviors were measured with the use of a diary filled out by the infants' parents over three days and nights. Additionally, infants' expressive and receptive language skills were measured using the Italian version of the MacArthur-Bates Communicative Development Inventories (MB-CDI, Caselli et al., 2015). Around 2 months later (M_{days} = 79, T2), all parents filled out the MB-CDI again.

The analyses showed significant negative correlations between the number of naps at T1 and expressive (p = .033) and receptive (p =.004) skills at T2. Moreover, there were significant and positive correlations between nap duration at T1 and expressive (p <.001) and receptive (p<.001) skills at T2. A regression analysis holding age constant confirmed this pattern for expressive skills only (F(5;14) = 16.50, p<.001, R^2= .855). The model shows that the change in expressive skills between T1 and T2 is mainly explained by the duration (p<.001) and number (p=.018) of naps at T1, rather than night sleep behaviors. Indeed, no significant associations were found between night sleep behaviors at T1 and expressive skills at T2.

These results indicate that infants napping less frequently at T1 showed a higher vocabulary growth than children napping less. Moreover, the data showed that the longer the duration of naps in children at T1, the higher their expressive skills at T2. Taken together, the results suggest that less frequent but longer naps at T1 predict better vocabulary outcomes at T2. It is well known that infants who experienced more interactions with parents show larger expressive vocabularies (Weisleder & Fernald, 2013), and that naps might facilitate consolidation of recently acquired information (Friedrich et al., 2020). Thus, we currently explore whether the relation between the number of naps and vocabulary outcomes is mediated by language experiences during their awake time. It is also possible that the sleep patterns attained in longer naps positively influence the efficiency of the consolidation mechanisms. Although in depth investigations are needed, the present study confirms that certain types of naps in the first years of life facilitate language growth.

P1-G-161 - Mental rotation from infancy to early childhood: A longitudinal study

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Details

Mental rotation (MR) ability plays a crucial role in spatial prediction and cognition, prompting extensive research on this cognitive ability from infancy to adulthood (Moore & Johnson, 2008; Frick et al., 2013; Jansen & Heil, 2009). Despite significant research in this area, there is a notable gap in longitudinal studies tracking the development of mental rotation. In order to gain insights into the intra-individual developmental trajectory of this ability from infancy to early childhood, we investigated the intra-individual development of mental rotation from 9-months of age until 4.6 to 5.5 years.
We tested 9-month-old infants with a live setup using a real modified Shepard-Metzler-object fixed on a rod. During the familiarization phase, infants were encouraged to manually explore the object by rotating it along the rod within the range of 0 to 239 degrees. In the subsequent test phase, we presented both the familiar object and its mirrored counterpart rotating along the previously unseen angles (240 to 360 degrees), and measured the infants' looking times. The results showed that especially crawling infants were able to differentiate between the familiarization and mirror objects (already published by Kelch et al., 2021).
Upon reaching the age range of 4.6 to 5.5 years, we tested the same cohort by administering two distinct mental rotation tasks. Firstly, we used a newly developed Mental Rotation Block task that consisted of the same Shepard-Metzler objects used before, and two 3D boxes with corresponding cut-outs of the objects. The task involved presenting the two objects in different orientations (along the X or Y axes) and various rotation angles (0 to 180 degrees) and one 3D box in which only one of the objects fits. Each child was asked (i) to point at the object that would fit into the box (perception) and (ii) to grasp and fit the object into the box (action). Secondly, we used a screen-based Video task involving the Shepard-Metzler object rotating from 0 to 239 degrees on the left side of the screen and two static objects on the right side: the familiar Shepard-Metzler object and its mirror object in different unseen angles (240 to 360 degrees). The task was to identify the static object that matched the rotating object on the left side. For both of these tasks, we recorded the total number of correct responses (accuracy).
Our preliminary results indicate that there is a positive correlation between the MR performance at 9 months of age and both, the perception phase ($r= 0.858$, $p= 0.06$) and action phase ($r=0.938$, $p< 0.01$) of MR Block Task performance. Interestingly, there is also a positive correlation between the MR performance at 9 months of age and the video task ($r= 0.704$, $p= 0.196$). This highlights the fact that children who were better at distinguishing an object from its mirror counterpart at infancy (especially the crawlers) tend to exhibit enhanced performance at the MR Block Task and Video Task during early childhood. This suggests a continual intra-individual development of mental rotation ability from infancy to early childhood.

P1-G-162 - 18- and 24-month-olds' tool-use learning and the role of verbal cues in an online looking-time study

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Details

Toddlers learn actions through observation of others. Although most everyday learning happens through face-to-face interactions, toddlers were increasingly exposed to screens and virtual communication during the Covid-19 pandemic (e.g., Bergmann et al., 2022). Research has consistently shown that learning actions from video-based presentations poses a challenge for toddlers (video deficit effect; Barr, 2010; Strouse & Samson, 2021). Based on findings that this effect is mitigated by pedagogical information (i.e., action narrating; Lauricella et al., 2016), the present study aimed to investigate the influence of the semantic content of verbal information on toddlers' action learning.
N = 89 18- and 24-month-old toddlers participated in a preregistered unmoderated online experiment at home, watching videos of demonstrations of two tool-use actions. On a box with two effect locations, one tool was used for a pressing, and the other for a pulling action (Figure 1 A+B), both actions producing the same sound effect. Each action demonstration was preceded by a specific ("… pressing in/pulling out") or unspecific verbal cue ("… doing that"). During four test trials (Figure 1 C), toddlers were presented with two pictures side-by-side, each depicting one of the tools being used at the same effect location of the box, which was correct for one tool (= correct tool use), but incorrect for the other tool (= incorrect tool use). From webcam recordings, we coded toddlers' looking behavior to both pictures, and calculated proportional looking times towards the incorrect tool use (LTincorr / (LTincorr + LTcorr)). Regardless of age and verbal cue, toddlers' proportional looking times did not differ from chance level, with no differences between groups (Figure 2). Thus, all groups did not show learning of tool-action associations. However, in a complementary lab-based study using live demonstrations, 18- and 24-month-olds (N = 88) showed learning of similar tool-action associations, with their imitative behavior being more accurate for toddlers who had heard the specific verbal information during demonstration, compared to the unspecific verbal information.
Taken together, the use of convergent measures provided important information: while toddlers can learn tool-action associations in a lab-based study, video-based learning in an online experiment is still challenging, and even semantically meaningful verbal cues did not effectively counteract these challenges. Nevertheless, the quality of webcam recordings was very satisfactory (only 3 % of trials had to be excluded), and parents indicated that their child enjoyed participating in the online experiment (M = 4.15; 5-point-Likert scale from 1 (very bad) to 5 (very good)). This demonstrates that for other research questions, unmoderated online experiments measuring looking times through webcam recordings could be a suitable complementary method to lab experiments with toddlers.

P1-G-163 - Limb movements and vocalizations to music during crying in infants at three- to four-month-old age

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Details

Background

Infants interact with music via limb movements and vocalizations even at 3- to 4-month-olds (Fujii et al., 2014). However, how infants interact with music before and after crying has not been fully investigated. Considering the accumulating evidence of auditory-motor interaction in early infancy (e.g., Rochat & Striano, 1999; Shinya et al., 2022), we hypothesized that, even when crying, infants would interact with music by modulating their limb movements and vocalizations. Thus, the present study investigated how limb movements and vocalizations during crying would differ depending on music in infants at 3-4-month-old age.

Methods

We analyzed the limb movements and vocalizations of infants when they listened to an improvised jam session by a drummer and a bassist (Music condition, the mean tempo of the music was 99.6 beats per minute, or 1.66 Hz, n = 11, 108-120 days old) and those without any auditory stimulus (Silent condition, n = 10, 110-118 days old). Four limb movements and vocalizations of the infants in the supine position were recorded by a motion capture system and the microphone of a digital video camera. We detected the moment at which each of the infants cried and analyzed the data separately before and after crying: pre-crying (Pre) and post-crying (Post). For limb movements, the mean square sum of velocity was calculated as a measure of movement amount. We performed power spectrum analysis and calculated the relative proportion of the power spectrum density (PSD) around the musical tempo (BPM ±10% range of frequency). For vocalizations, to assess the rhythms, we calculated the power - spectrum of temporal modulations of vocalizations (Ding et al., 2017) and compared the peak frequency (Figure 2A).

Results

We conducted a 2 (Condition; Silent vs. Music) × 2 (Phase; Pre vs. Post) ANOVA for limb movement and vocalization measures. For limb movements, there was no significant interaction ($F_{1,19}$ = .717, p = .407) nor main effect of Condition ($F_{1,19}$ = .041, p = .841), although the main effect of Phase was significant ($F_{1,19}$ = 4.56, p = .046; Figure 1A). For an infant who demonstrated striking increases in the movement amount after crying in the Music condition (ID13), the relative proportion of PSD around the musical tempo increased from 13.30% to 19.45% after crying (Figure 1B). For vocalizations, there was no significant main effect of Condition ($F_{1,38}$ = 0.30, p = .586) on the peak frequency. However, we found a significant interaction between Condition and Phase ($F_{1,38}$ = 4.48, p = .041) and a significant main effect of Phase ($F_{1,38}$ = 7.13, p = .011), showing that the infants significantly decreased the peak frequency of temporal modulations after crying in the Silent condition (t = 3.03, p = .014), but not in the Music condition (Figure 2B).

Discussion

We could not find a difference in the limb movement amount between the Silent and Music conditions, but an infant (ID13) strikingly increased the limb movement at around the musical tempo after crying. In addition, infants were more likely to maintain vocal rhythm in the Music condition than in the Silent condition. These results indicate that infants are influenced by music and support the possibility that infants show precursor behaviors to interact with music even when crying.

P1-G-164 - Object permanence continues to develop up to 3 years of age

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Details

Keen (2003) reported that 2-year-olds failed to find a toy that rolled behind a wall with 4 doors, and then stopped behind one door due to encountering a barrier; the barrier was taller than the wall so children could see where the barrier was. To probe these surprising search failures, we stripped the task down to a stationary, 2-door search task. Table 1 shows a schematic of the apparatus, and gives descriptions of the three versions (Hide-Door, Reveal-Doorways, Reveal-Rooms) of the task, which vary how the experimenter hides the toy. In each version, children see the toy in its location for 4 seconds before occlusion, and the delay is 5 seconds before searching. Children are allowed to open one door per trial, so if they search incorrectly they do not get the toy. A new toy is used on each trial. Children received 2 trials on Hide-Door, and 4 trials on each of the two Reveal versions.

In our earlier studies, 22-month-olds performed as poorly on Reveal-Rooms as they had on Keen's (2003) rolling-toy, 4-door apparatus; correct performance was at chance levels in both. On Hide-Door, however, their performance was at ceiling. In the current study, we added Reveal-Doorways to test the possibility that children succeeded on Hide-Door by simply imitating the experimenter's actions of opening and closing the door while hiding the toy; in Reveal-Doorways, like Reveal-Rooms, the experimenter does not open and close the correct door. We tested 138 children at 5 age levels (see Figure 1). Each child received all three versions.

At 20-24 months, children succeeded on both Hide-Door (mean proportion of correct searches = 1.0) and Reveal-Doorways (.90), suggesting they were not simply imitating the experimenter's actions. Surprisingly, each version had a distinct developmental trajectory. There was no developmental change on Reveal-Doorways, as expected on an object permanence task at these advanced ages. But there was dramatic developmental change on Reveal-Rooms: 20-24-month-olds were at chance (.56), and it was not until 18 months later (37-42 months) that performance plateaued at the level of Reveal-Doorways. What makes success possible for 2-year-olds on Reveal-Doorways, but not on Reveal-Rooms? Table 1 shows what we think is the important difference, which occurs during the 4-second interval before occlusion: In Reveal-Doorways (and also in Hide-Door), the child sees the toy in the open doorway, thereby receiving a single perceptual image that conjoins the toy to that doorway. In Reveal-Rooms, the child sees the toy in the room, and when the wall is lowered the child has to mentally conjoin the perceptual image from a moment ago (toy in that room) to the present image (the door to that room). We discuss how the temporal aspect of representation could play a role in continued development of object permanence skills. Finally, in Hide-Door, performance actually decreased across the younger ages, which might reflect development of curiosity and an ability to consider the possibility that something else might be behind the other door which remains closed.

P1-G-165 - Inhibitory control at 18 months and the early influences on its development

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Details

Inhibitory control refers to the ability to suppress a dominant or automatic response and provides an important component of executive functions. While the development of inhibitory control begins in the first year of life already, the majority of studies conducted so far have focused on the preschool period. The objective of this study is to test inhibitory control at a much younger age (i.e., at 18 months) using the Detour Reaching Task. Also differing from most previous studies, the study will be based on a socially and/or culturally disadvantaged sample.

300 families and their children living in disadvantaged neighborhoods in Bremen, Germany, participated in the longitudinal study "Bremen Initiative to Strengthen Early Childhood Development" (BRISE). During pregnancy and 3 and 7 months after birth, parental education and employment, migration background, and family language were assessed. When the children were 7 months of age, positive and negative maternal behaviors were macroanalytically coded during a five-minute semi-structured play situation. At 18 months of age, the children participated in the Detour Reaching Task (DRT). In this task, they were asked to retrieve a toy from a transparent box. In a first phase, the front side of the box is open so that the child can reach directly for the toy, but in a second phase, the side of the box is opened so that the child must inhibit his or her first impulse and make a "detour" to reach for the toy. The DRT is one of the few tasks to test inhibitory control at one to two years of age.

So far, 78 children have taken part in the DRT. Preliminary results indicate that (a) the DRT is suitable for measuring inhibitory control at the tested age-range, and (b) associations between family factors and inhibitory control can be found at 18 months already. Among various maternal behaviors, it appears that maternal stimulation and emotionality are particularly important for inhibitory control at two years of age. Additionally, maternal education is a better predictor of inhibitory control in young children than paternal education. Finally, children with a migration background who grow up bilingually perform less well in the DRT, indicating poorer inhibitory control. The study's results will be discussed in relation to the socioeconomic characteristics of this specific sample.

P1-G-166 - Relations between the timing of caregiver process praise and toddlers' persistence and effort-related expectations

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Details

Caregiver language shapes young children's values and expectations. This appears to be particularly true in fostering children's mindsets toward persistence: greater amounts of process praise (i.e., effort-based praise) have been found to facilitate persistence even in toddlerhood (Lucca et al., 2019). However, process praise timing may be important, not just volume: while receiving praise after overcoming a challenge likely feels motivating, receiving praise when you are not trying or succeeding may feel confusing. Thus, we explored how the timing of caregiver process praise related to toddlers' persistence, as well as their expectations that effort leads to success. In Experiment 1, toddlers (N = 60, mean = 22.57 months, range: 16.77-31.42 months; 31 females; 40% White) completed a "gear-stacking task" with their caregivers, and caregiver process praise was categorized based on timing: Trying Only (i.e., praise only when toddlers tried), Success Only (i.e., praise only when toddlers succeeded), Both (i.e., praise during trying and success), or Random (i.e., praise during neither trying nor success). Results indicated that toddlers who received more Both utterances stacked more gears controlling for all other praise types ($\beta = 0.94$, $p = .002$) and overall process praise ($\beta = 1.01$, $p < .001$). Interestingly, Random praise had a negative effect: infants who received more Random praise stacked fewer gears ($\beta = -0.75$, $p = .03$). Likewise, simply receiving large volumes of process praise did not increase persistence, as overall process praise negatively predicted persistence when controlling for Both utterances ($\beta = -0.72$, $p = .001$). Thus, individual differences in caregiver process praise timing influence toddlers' persistence. Further, one reason that process praise is thought to encourage persistence in older children is by shaping positive mindsets towards effort (e.g., Gunderson et al., 2013). Thus, Experiment 2 is exploring how individual differences in caregiver language may also shape toddlers' expectations of effort and success. After the dyadic session, infants are familiarized to two agents retrieving a toy. One agent exerts high effort, and the other low effort; yet, at test, both agents succeed allowing us to measure violation of expectation. While data collection is ongoing, pilot data suggests toddlers do not have a baseline preference for either agent (MDiff = 0.18s, $t(65) = 0.17$, $p = .87$). As such, variability in caregiver language may be particularly influential during this developmental period. Indeed, preliminary data from Experiment 2 (N = 10 out of 96), suggest infants who received more Both utterances looked longer when the low-effort agent succeeded (versus the high-effort agent; $\beta = 2.39$, $p = .15$), but that high-volume process praise ($\beta = -3.27$, $p = .03$) and Random praise ($\beta = -3.34$, $p = .05$) related to smaller differences in looking. Thus, this work suggests that individual differences in the timing of caregivers' process praise not only influences toddlers' persistence but may also shape their toddlers' expectations. When toddlers received more praise which was misaligned with their effort (i.e., high-volume or random), they persisted less during problem-solving and exhibited lower expectations that effort leads to success.

P1-G-167 - Infants' sensitivity to the statistical regularities of natural scenes.

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Details

Natural (real-world) scenes are rich with statistical regularities of color and space. For example, there are regularities in the relationship between spatial and contrast information, edges and texture, and in the distribution of color and luminance (Long et al, 2006). Adult vision appears to be sensitive to these statistical regularities and optimised to represent natural scenes. Here, we present a series of studies which aim to establish whether infants' ability to process statistical information in language, face or

object representation (e.g., Aslin et al., 2012) extends to infants' being sensitive to the statistical regularities of natural scenes.

First, we present our study which investigates whether infants' sensitivity to color is aligned with the distribution of colors in natural scenes (Skelton, Franklin & Bosten, 2023). Natural scenes have greater variation in colour along the blue-yellow than red-green direction of colour space, and adults' sensitivity to color reflects this distribution (Bosten et al, 2015). We measured saturation thresholds for 8 hues in 64 4-8-month old infants using a novel gaze-contingent psychophysical target detection task. We find that infants' sensitivity to different hues is aligned with the distribution of color in natural scenes, as it is in adults. This suggests that color vision is 'tuned' to optimally represent natural scenes on an evolutionary time scale, or in the first few months after birth when trichromatic color vision develops.

Second, we present a study which examines whether infants' visual preferences for complex scenes also reveals infants' sensitivity to natural scene statistics (Skelton et al., in prep). A prior study with 4-11 year olds found a gradual development of aesthetic preference for scenes of nature over scenes of urban environments (Meidenbaur et al., 2019). Our study with 4-9 months old infants (N=28) examines if infants have a visual preference for one scene type over the other, and examines whether a visual preference for certain kinds of scene statistics can account for this. Looking time data collected remotely via color-calibrated iPads revealed that infants looked longer at urban than nature scenes, mirroring the aesthetic preference in young children. Image analyses computed a range of spatial and chromatic scene statistics for the images, and a partial least squares regression identified a number of scene statistics (e.g., edge density) that accounted for almost all of the variance in infant looking.

Both of these studies suggest that infants are sensitive to some of the statistical regularities of natural scenes. Finally, we consider what statistical information in scenes is available to infants given their immature vision. We present a digital filter which simulates the appearance of images to infants based on psychophysical data measuring infant visual sensitivity. We apply the filter to images of egocentric scenes that we have collected from 3-12 month-old infants wearing color-calibrated head-mounted cameras. We illustrate how infants' reduced visual sensitivity affects the visual statistics of their scenes.. This digital filter provides a tool for others using head-mounted cameras with infants, and clarifies what kind of scene information infants' can actually see at various stages of their visual development.

P1-G-168 - Does play with the Pattern Alphabet promote children's and parents' language and questions?

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Details

Born from the intersection of design and cognitive science, the Pattern Alphabet (pABC; Wolf, 2022) (Figure 1) introduces a new way of thinking about shapes by emphasizing the spatial properties in children's environments and objects. The pABC contains 32 forms commonly found in nature, such as *spirals* and *symmetry*, that go beyond typical geometrical shapes. Interactions with the pABC may

impact spatial cognition as identifying shapes relates to early spatial skills—the ability to visualize, transform, and manipulate space and objects in one's environment (Uttal et al., 2013; Verdine et al., 2017). Spatial skills are fundamental for both completing daily tasks, such as packing a suitcase, and success in STEM disciplines (Uttal et al., 2013).

Young children's spatial skills significantly improve with increased exposure, comprehension, and production of spatial language (Casasola et al., 2020; Pruden et al., 2011). Additionally, children learn more vocabulary when adults ask more questions (e.g., Rowe, 2018). Thus, we ask: How does the quantity (i.e., amount) and quality (i.e., diversity) of both the spatial language and questions used by parent-child dyads differ during playing with pABC shapes compared to play with commonly known shapes?

How do parents and their 30- to 42-month-olds engage in two guided play activities featuring an experimentally made shape sorter? One set is pABC forms; the other set features shapes found in shape sorters (Resnick et al., 2016) (Figure 2). In both counterbalanced conditions, parents are instructed to encourage their child to sort color photographs with an embedded shape or form (i.e., pizza) into a corresponding slot on the shape sorter (i.e., triangle). Children's spatial skills are assessed through the Woodcock-Johnson IV: Spatial Relations Subtest (Schrank et al., 2014). Language comprehension is measured with the Quick Interactive Language Screener (QUILS; Golinkoff et al., 2017). The QUILS serves as a control variable: children's language abilities may affect parents' spatial language and questions. All sessions are video-recorded, and dyads' language are coded offline. Data collection is ongoing.

The number of spatial words used and questions asked (quantity) will be calculated for each play activity. Quality of spatial language will be calculated using the number of unique spatial words, and further assessed by coding described by Cannon et al. (2007). Quality of questions will be assessed using the proportion of parents' child-led questions—questions that follow children's attention, utterances, and actions. These questions are the most successful for promoting children's language development (e.g., Gaudreau et al., 2024; Weisberg et al., 2013). Three 2-way repeated measures ANCOVAs will be used to assess whether the quality and quantity of spatial language and questions (dependent variables) result from the interaction between the type of shape sorter task and the order in which tasks were administered; QUILS performance will be entered as the covariate. Multiple regression analysis will examine how the quality and quantity of parental spatial language and questions predicts children's spatial skills. Future directions and implications of the research will be discussed.

P1-G-169 - Examining the role of caregiver-infant contingency in driving the development of inter-personal prediction during early social interactions: a naturalistic EEG study

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Details

Predicting the response of a social partner to modulations in one's own behaviour is fundamental to creating and organising interpersonal contingencies (co-ordination of joint attention) during free-flowing interactions. At the moment, however, we know little about the anticipatory attentional processes that operate during social interactions in early infancy, and whether the development of these processes is influenced by infants' experiences of behavioural contingencies in interactions with their caregiver. We

define parental contingency as the proportion of child-led looks met by the parent during a free flowing play interaction between 12-month-old infants and their parents, with a higher proportion of child-led mutual gazes indicating greater parental contingency. Oscillatory activity, specifically suppression of the alpha-band (6-9 Hz), will be compared between dyads, as this has previously been found when infants anticipate their gaze being followed by their parent (Phillips et al., 2023). We will then compare infants' behaviours and oscillatory activity between an interaction with their parent and an interaction with a stranger, to investigate whether greater parental contingency produces a similar, generalised anticipation for their looks to be followed.

P1-G-170 - Differential looking times, EEG, and neural networks as measures of visual representation in infants

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Details

Infants cannot explicitly report their mental states and representations, and thus experimenters have to uncover those representations through implicit measures, such as looking times. Differential looking times have been proposed as a behavioral index of representational distance in preverbal infants (Spriet et al, 2021). However, how this behavioral metric relates to underlying neural representations remains unknown: two images may be represented in different ways without eliciting a looking preference for either, and multiple factors (from lower-level perceptual properties to high-level semantics) may drive looking times. To address this gap, we compare infants' representations of visual objects estimated in a looking time task to those estimated in an electroencephalography (EEG) task. In an in-progress EEG study, 12-15-month-old infants (target: N = 75) are shown individual pictures of commonplace objects (e.g. bananas, cats, faces, bottles) while their EEG activity is recorded (Figure 1). The recorded EEG activity is analyzed using multivariate pattern analysis, which provides a measure of how dissimilar EEG activity is between objects at each time point. This information is used to create representational dissimilarity matrices (RDMs), which provide a visualization of the representational similarity of objects as indicated by EEG. In a parallel, in-progress looking-time study, a separate group of 12-15-month-old infants (target: N = 100) are shown pairs of the same pictures, and their differential looking times are also interpreted as a measure of representational dissimilarity and used to create RDMs. We then use representational similarity analysis (Spearman's correlations) to compare the RDMs that are created from neurological and behavioral data (Figure 2). These analyses has been pre-registered through AsPredicted (#167442). While results are preliminary, they currently do not show any correlation between the behavioral and EEG data. If these results hold in the full sample, they would indicate that looking directions may be unrelated to underlying neural representations as measured here, or that the connection between looking directions and these neural representations may not be well captured by our task.

Similarly, we will compare differential looking times to deep neural net (DNN) models of vision. Specifically, we will create RDMs of our stimuli as interpreted by the DNNs VGG19 (Layer 4) and CORnet S (last full layer). These RDMs will be compared to the differential looking time RDMs using representational similarity analysis. This will allow for a deeper understanding of how computer vision

models compare to natural vision development, which will be useful in the development of computer models that more accurately imitate human brains and behavior. Computer models that are more similar to humans, and particularly to infants, are useful in that they facilitate more accurate predictions about how individuals will react to certain stimuli and how brains develop.

Findings from this work will inform future research using converging measures from EEG, differential looking times, and computer vision models to assess infants' visual representations. The findings will also give greater insight into how infants represent visual objects both neurologically and behaviorally, how those representations change over time, and how those representations compare to computer models.

P1-G-171 - Moral protest longitudinally supports the development of moral judgment

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Details

Early in life, children begin to appreciate how one should (not) act within their socio-cultural community. Therein, explicitly judging others' behavior as (im)permissible and protesting against norm violations are foundational capacities emerging at about 2 to 3 years (e.g., Marshall & McAuliffe, 2022; Rhodes & Wellman, 2017; Vaish et al., 2011). However, explicit moral judgment and spontaneous normative protest have largely been studied in different literatures and little is known about their co-development and stability early childhood. This severely limits our understanding of the emergence of morality. From a social-interactionist and social domain perspective (Carpendale et al., 2013; Smetana, 2013), (1) moral protest can be conceptualized as a precursor of explicit moral judgements and (2) both indicators of early moral stances should evidence stability in early childhood. The latter should especially hold in the moral as opposed to the conventional domain, that represents more arbitrary social agreements compared to moral rules revolving around justice and others' welfare.

The current study directly tested both predictions in a longitudinal design. At 2.5 (N = 87) and 3.5 (N = 74) years of age, we presented children with the same two moral (e.g., hitting someone) and two conventional (e.g., sorting objects into the wrong box) transgressions. In each transgression trial, a puppet explained a social norm by describing what one ought to and ought not to do, whereafter children witnessed a transgressor puppet violate the norm. Lastly, the experimenter asked children evaluation questions. We recorded children's spontaneous verbal protest (e.g., "No", "This is not ok") and physical interventions (e.g., holding the puppet back, using gestures to indicate the right course of action) as protest behavior. In addition, we assessed how ok children judged the transgressions.

A Cross-Lagged Panel Model (CLPM) revealed that the more children protested with 2.5 years the less OK they judged transgressions with 3.5 years. Moral judgments at 2.5 years, on the other hand, did not predict moral protest behavior at 3.5 years (see Figure 1). No significant relations were found for the conventional CLPM. A further CLPM demonstrated that moral but not conventional protest behavior showed longitudinal stability (see Figure 2). This pattern also emerged for moral (p = 0.048) but not conventional (p = 0.812) judgments.

Our findings advance developmental theorizing by connecting spontaneous normative protest and explicit moral judgment in early moral development with early protest behavior supporting the development of later explicit judgments. Morality evidences greater stability than conventionality, speaking for accounts stressing the preeminence of moral stances. Taken together, this work broadens our understanding of the early development of morality.

P1-G-172 - The nature of neonates' contagious crying: a longitudinal investigation of infants' responses to others' distress

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Details

Research suggests that rudimentary forms of empathic responding might be evidenced from birth. Simner (1971) first demonstrated that 3-day-old infants will cry when they hear a recording of another newborn crying versus when hearing a synthetic cry, white noise, or the cry of an older infant. Replications of the 'contagious crying' paradigm have found similar neonatal responses using different control variables (e.g., recordings of own cry, chimpanzees) and younger participants (Martin & Clarke, 1982; Sagi & Hoffman, 1976). Combined, this work suggests that neonates' emotional reactions to others' cries are species- and age-specific reflexive responses, argued to represent a rudimentary form of empathy (Decety & Jackson, 2004; Geangu et al., 2011). It remains unclear, however, whether neonates' response to an age-matched peers' cries is indeed driven by the emotional content of the recorded cry. Critics suggest that prior work on neonates' contagious crying is limited by insufficient controls that cannot account for explanations that neonates' responses merely represent a negative reaction to aversive or novel stimuli (Ruffmann et al., 2017). Recent work on the development of empathy indicates that behavioural markers of empathic concern are evidenced in 3-month-olds, remain moderately stable across infancy, and predict comforting behaviours in the second year of life (Davidov et al., 2021; Paz et al., 2022). However, no studies to date have investigated the association between neonates' 'contagious' crying and empathic responding at later points during infancy; doing so could inform the debate on the other-oriented, empathic nature of neonates' response to other's cries.

The current study uses a longitudinal design to examine whether individual differences in neonates' distress contagion (< 5 weeks) predicts those same infants' empathic concern for distressed experimenters and peers at 3 and 10 months. All data is collected as part of an ongoing large-scale longitudinal study. At time 1, neonates listen to a 4-minute recording of other neonates' crying and their latency to cry in response (minute of cry, scored 1 - 4) is coded from video. At 3 and 10 months old, the same infants sit across from an experimenter who "injures" their finger with a toy hammer and subsequently simulates pain for 60 seconds (Davidov et al., 2021). Additionally, 10-month-olds watch a 55-second video of an age-matched peer in distress (Paz et al., 2022). During these episodes, infants' facial expressions and vocalizations are coded for intensity of concerned affect (0-3). Data collection is ongoing (target N ~80); however, preliminary regression analyses (n = 46, 43% female) indicates that neonates' (Mage = 1.07 months) latency to respond to others' cries is associated with their expressions of concern towards an injured experimenter at 10 (but not 3) months old (Mage = 10.41 months, R2 = 0.115, p =.03). Although 10-month-olds' concern for a distressed experimenter (live-action) and peer

(video) were correlated (r = .29, p =.04), neonates' latency to cry predicted concern directed towards an experimenter, but not a peer at 10 months old (p =.31). Implications for the theoretical debate on neonatal contagious crying will be discussed.

P1-G-173 - The longitudinal predictive significance of maternal sensitivity for infant attachment cognitions

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Details

Maternal sensitivity serves an important role in the development of attachment (De Wolff & Van IJzendoorn, 1997). Attachment theory (Bowlby, 1973) posits that these early caregiving experiences are represented as Internal Working Models (IWMs), comprising views of the self, others, and the nature of relationships. These representations guide preferences, beliefs, and expectations about the social world, and are thought to generalize across all close relationships. Thus, infants' cognitive representations are thought to be a key mechanism by which early attachments impact socioemotional adjustment (Bretherton & Munholland, 2008). Until recently, links between infant attachment and cognitive representations have been under-investigated. The current study bridges this gap by examining longitudinal predictive significance of caregiving experiences assessed prior to 12 months for their attachment-relevant cognitions. We predict that infants' attachment cognitions will be informed by their history of caregiving experiences.

In an ongoing, longitudinal study, infant-mother dyads (planned N=100) are recruited to participate in two testing sessions (order counterbalanced) at 13- and 14-months to assess infants' cognitive representations in attachment-relevant scenarios. In one visit, infants participate in a Violation-of-Expectation (VOE) looking-time task using videotaped events with puppets featuring a separation scenario, based on Johnson et al. (2007, 2010). In these events, to start, a woman next to a baby moves away, the baby then begins to cry. The woman returns to the baby (responsive) or continues to move away (unresponsive). Infant looking times at these events are measured to determine whether infants expect the woman to return to the crying baby following the separation. In another visit, infants participate in a Preferential-Looking (PL) task. They first watch videos of adult women either comforting (responsive) or ignoring (unresponsive) a crying baby, based on Jin et al. (2018). Infants are then presented with the two women's faces simultaneously and their relative looking to each is coded to assess whether they hold a preference for the responsive over the unresponsive woman.

For the dyads, maternal sensitivity responding to infant distress and non-distress was assessed when infants were 4 months during caregiving (e.g., diaper change), play, and distressing tasks (e.g., Still-Face Procedure) using scales adapted from the NICHD Study of Early Childcare (Frosch & Owen, 2016).

We predict that infants with more sensitive mothers will expect the adults in the VOE task to be responsive to infant attachment signals (e.g., infant crying) and will prefer responsive to unresponsive adults in the PL task. In contrast, infants who have a history of experiencing unresponsive or less sensitive caregiving may hold different expectations and preferences. Preliminary findings from 27 infant-mother dyads provide promising evidence for such claims, as results indicate a medium-large effect of greater maternal sensitivity on infants' longer looking time at unresponsive caregiving in VOE task, suggesting they find it unexpected (r = .27), and a longer looking time at the responsive woman in the PL task, suggesting a preference for her (r = .26). If such trends in results held, this would indicate that maternal sensitivity indeed informs infants' IWMs.

P1-H-174 - The interplay of oxytocin receptor (OXTR) gene and first-person ostracism experience on infants' behavioral reactivity

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Details

Available research demonstrates that the oxytocin system is involved in regulating complex social behaviours, encompassing affiliative behaviours and responses to social stressors (Bakermans-Kranenburg & van Ijzendoorn, 2014). Specifically, allelic genetic variations, encompassing single nucleotide polymorphisms (SNPs), within the oxytocin receptor (OXTR) have been linked to human emotional responsiveness and social behavior, thus contributing to explain individual differences observed in several social behaviours both in adults and children (e.g., Wade et al., 2014; McQuaid et al., 2015). Recent studies found that more copies of the minor allele (A) are associated with lower levels of social cognition (i.e., heightened-risk for poorer social performance), whereas more copies of the major allele (G) are associated with higher levels of social cognition (i.e., minor-risk) (Wade et al., 2014). In light of oxytocin's role in social behaviours, some studies demonstrated that this neurohormone contributes to mechanisms underlying humans' sensitivity to social exclusion (Petereit et al., 2019). However, to date, it is unclear whether variability in the endogenous oxytocin system is associated with individual differences in infants' behavioural reactivity to ostracism (i.e., the experience of being ignored by others). The current project aims at investigating whether behavioural reactivity to a first-person experience of ostracism is modulated by innate predispositions (i.e., allelic variations in specific OXTR SNPs) in 13 months-old infants. Fifty-four infants participated in a real-time triadic ball-tossing game with two experimenters, experiencing either inclusion (N=30) or ostracism (N=24). During inclusion, infants received and threw the ball one-third of the time, whereas those in the ostracism condition received and threw the ball only twice at the beginning and were subsequently ignored for the remainder of the game. Video recordings of the interaction were analyzed by using an observational coding system that allowed for micro-analytical coding of the frequency of facial, vocal, and postural expressions and behaviours (Quadrelli et al., 2023). Those sets of behaviors were then clustered, creating different indexes: positive and negative emotionality, active engagement and visual attention. Subsequently, a sample of infants' saliva was collected using a Pediatric DNAgenotek kit (REF: OCR-100). Building upon prior evidence, allelic variations of four distinct OXTR SNPs were examined, namely: rs53576, rs2254298, rs11131149, and CD38. Preliminary analyses exploring differences in behavioural reactivity to social inclusion and ostracism between infants carrying heightened-risk (AG/AA) vs minor-

risk (GG) genotypes highlighted the existence of a marginal interaction effect between rs11131149 and the social interaction condition (p= .061). Specifically, when ostracized, infants carrying heightened-risk allelic variation displayed more negative affectivity compared to infants with minor-risk allelic variations (p=.034). The present findings suggest that genetic variations within the OXTR influence infants' reactivity to social ostracism and their involvement in social interactions. While data collection is still ongoing, current preliminary results underscore the potential for further exploration of the role of genetic information in social cognition, shedding light on the interplay of how genetic predispositions may modulate early interactions with the environment.

P1-H-175 - Stable individual differences in human and monkey neonatal imitation

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Details

Neonatal imitation—an infant's ability to match others' behaviors in the 28 days after birth—is theorized to provide insights into social development (McGowan & Delafield-Butt, 2023). Neonatal imitation is reported in humans (Meltzoff & Moore, 1977) and macaques (Ferrari et al., 2006). However, it is difficult to elicit at the group level (Davis et al., 2021), in part, because infants display individual differences (Heimann et al., 1989). Averaging across infants may, therefore, mask meaningful individual variability. Here, we explored individual differences in human and monkey imitation across behaviors and ages.

We longitudinally tested healthy, full-term U.S. human newborns' (*N*=77, age 6-28 days; 35 females, 35 Hispanic/Latino, 19 Black, 17 Non-Hispanic White, 7 multi-racial) and monkey newborns' (*Macaca mulatta*; *N*=136, age 1-8 days) tongue protrusion, and mouth-opening (in humans) or lipsmacking (in monkeys), compared to a nonsocial disk to control for arousal (Figure 1), using a lab-based, burst-pause procedure (Meltzoff & Moore, 1983). We tested humans twice (1 week apart) and monkeys four times (every other day). For each gesture, we counted the matching gestures to the corresponding face condition and subtracted the gestures in the disk control condition, then converted them to a rate per minute. Each infant, therefore, had an imitation score for each gesture at each age.

In humans, we detected no imitation, on average across ages, for either gesture, *p*s>.10. In monkeys, we detected lipsmacking imitation, $t(162)=2.75$, $p=.007$, $d=.215$, but not tongue protrusion imitation, *p*s>.10. However, averages may mask meaningful individual differences (Pérez-Edgar et al., 2020). We also explored whether there were improvements or declines in imitation, on average, with age. We detected no changes with age for either species within the first month (for humans) or first week (for monkeys) after birth (*p*s>.05). However, these assessments were relatively closely spaced apart in time (a week in humans or a couple of days in monkeys), so we may have been unable to capture developmental changes.

Human infants' tongue protrusion and mouth opening rates (averaged across ages) were positively correlated, $r(76)=.351$, $p=.021$, Figure 2a. Similarly, monkeys' tongue protrusion and lipsmacking rates

were positively correlated, $r(135)=.185$, $p=.031$, Figure 2b. Our results suggest that neonatal imitation may be indexing a stable individual difference in both species potentially reflecting a broader behavior-matching capacity.

Yet, individual differences in imitation indices at one age were not correlated with imitation indices at another age (ICCs<.20), highlighting the importance of multiple assessments across ages to capture individuals' imitative skills (Simpson et al., 2014).

Findings are consistent with the proposal that neonatal imitation is a stable individual difference. However, it is unclear what this variability reflects. Studies report monkeys' neonatal imitation predicts later social outcomes–including eye-contact (Paukner et al., 2014) and positive peer interactions (Kaburu et al., 2016)–yet, no studies have explored these outcomes in humans. Large-scale replications, such as ManyBabies6, will test factors contributing to individual differences to provide insights into potential mechanisms.

P1-H-176 - Building infant-grandparent closeness through structured and unstructured video chats

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Details

Close grandparent-grandchild relationships support both the grandchild and the grandparent through benefits to their health and their psychological well-being (Duflos et al., 2020; Sadruddin et al., 2019). The frequency of contact between grandparents and grandchildren predicts how close they feel (Attar-Schwartz et al., 2009; Attar-Schwartz & Fuller-Thompson, 2017; Hakoyama & Malone-Beach) and in a recent study, contact was extended to include the frequency of video chat contact (Strouse et al., 2021). Researchers have recommended that families engage children under 3 during video chat through play activities, games, and shared reading (Barr et al., 2018). Structuring video chat interactions to promote reciprocal interaction and shared focus may lead to more engaging and enjoyable experiences that promote feelings of closeness for both grandparents and grandchildren. However, the impact of structuring family video chats on family relationships has not been systematically tested.

In the current pre-registered study, we are tested whether grandparents' and parents' ratings of the closeness of the grandparent-grandchild relationship increased after families engaged in a series of 11 video chats. Grandparents, parents, and infant grandchildren (18 to 36 months) were asked to record video chats approximately 2x per week. After completing a baseline unstructured (no assigned activities) video chat, families were randomly assigned to participate in 9 structured video chats (play or reading) or unstructured video chats. The final video chat was unstructured for all participants.

Grandparents rated how close they felt to their grandchild on a 17-item survey developed by Lee et al. 2023 at the beginning and end of the study. Parents rated how close they thought their grandchild felt to their grandparent on the same 17 items, adapted to be appropriate for parent report. The preliminary analyses presented here are based on repeated-measures analyses with N = 20 families, which is approximately one-third of the final planned sample. Updated analyses with more families will be presented at the conference.

For grandparents, there were no main effects, but there was a significant time by structure interaction, $F(1,18) = 7.07$, $p = .016$, $\eta^2_p = 0.28$. Post-hoc tests indicated that contrary to our hypothesis, there was significant growth in closeness in the unstructured condition, $p = .009$, but not in the structured conditions, $p = 538$. One likely reason for the lack of growth in closeness in the structured condition is that grandparents reported very high levels of closeness at baseline (Table 1). For parents' ratings of their infants' feelings of closeness, there were no significant main effects or interactions.

We are also collecting information about how close families feel *during* each of their 11 study video chats; this data will be available at the conference and allow for a more direct comparison between structured and unstructured chats. Future behavioral coding of video chats will provide insights regarding how different structured activities relate to shared attention, engagement, and enjoyment of video chats, and how those constructs relate to feelings of closeness. This will support practical recommendations for families and theoretical understanding of what types of contact best support infant-grandparent relationships.

P1-H-177 - Impacts of parental behavior on attention in children with cochlear implants

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Details

Impacts of Parental Behavior on Attention in Children with Cochlear Implants

Parent-based interactions are foundational to early life language acquisition. These interactions dominate language exposure during these formative years for both normally hearing (NH) children and children implanted with Cochlear Implants (CIs); however, children with CIs tend to exhibit delayed language development compared to that of NH peers. A possible source of language delay for children with CIs could be attributed to small behavioral differences parent and child exhibit when interacting.

Free-flowing interactions are littered with distraction opportunities. Parents often attempt to shift their child's attention, manufacturing moments of synchrony. Synchronous attention plays a critical role in a child's vocabulary acquisition (Yu and Smith, 2012). During toy-based play, parents engage with novel objects through touch, talk, or both. A factor that may influence children's learning during parent-child interactions could be how children respond to bids for attention. To explore this possibility, this project takes a first step by investigating child attentional shifts in response to parent behavior during free-play toy-based interactions.

We analyzed audiovisual data taken during free-flowing toy-based interactions between parents and children, using head-mounted eye tracking to capture first-person perspective of visual attention of both the parent and child. A shift attempt was defined as instances in which a parent presents a toy (Object B) while the child is attending another toy (Object A). The subsequent reaction of the child, to shift attention or ignore the parents' attempt, is hypothesized to be dependent on two factors: 1) the duration of the child's fixation to Object A before the parent introduces Object B (Pre-Object B look duration); 2) parents' choice of unimodal or bimodal presentation.

Preliminary analyses were conducted on a small sample of 2.5-year-olds (two CI dyads and two NH). As predicted, we found that children that the mean proportion of attention shifts was significantly higher in the bimodal condition (.86) than in the unimodal condition (.41) ($p < .05$), suggesting that parents' use of both talk and touch when presenting a different toy is more likely to garner their child's attention than if one modality is used. Mean Pre-Object B look duration was 5.6s when attentional bids were ignored and 4.7s when shifted occurred, but this difference was not statistically significant. However, when shifts did occur, there was a strong relationship between duration of Pre-Object B look duration and latency to shift to Object B ($r=.93$, $p<.05$), suggesting some role of look duration on inhibition of attentional shifting.

Future analysis for 12 total dyads includes data on word learning outcomes as well as additional analysis aimed to compare trends found between the two groups (CI and NH) as well as cross-comparison between dyad members. Through understanding unique attentional patterns that exist between CI child and parent suggestions can be made that highlight malleable behavior patterns parents exhibit during play with their child. Modifications in parent behavior can help to increase instances of synchronous attention, providing CI users access to valuable early-life language experiences that improve language outcomes.

P1-H-178 - Fathers' and mothers' childrearing values: Similarities, differences, and associations

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Details

Parents' childrearing values—the qualities that parents desire their children to develop—guide parenting practices and may be especially influential during infancy. Indeed, mothers' childrearing values for infants shape their parenting practices and impact children's self-regulation, thereby exerting

long-standing effects on psychosocial and academic outcomes into childhood and adolescence. Yet research on fathers' childrearing values during infancy, and comparisons of childrearing values between fathers and mothers, is rare. There's an urgent need to document similarities and differences in fathers' and mothers' values on average (i.e., in the group), and to quantify agreement in childrearing values in individual father-mother pairs.

This study aims to (1) compare childrearing values endorsed by fathers and mothers for their boys and girls, based on aggregated data across the group; (2) quantify the degree of agreement on childrearing values between individual father-mother pairs; and (3) explore the social-cultural correlates of fathers and mothers' childrearing values.

Data from over 442 parents (49% fathers; 205 fathers) of 2- to 3-year-old children from diverse English- and Spanish-speaking families across two samples (N=76 parents in sample #1; N=366 in sample #2) were analyzed. To capture parents' childrearing values, fathers and mothers were asked to rank in order of importance a list of fifteen childrearing values.

Results show that fathers and mothers in the US emphasized both individualism (self-esteem) and connectedness (kindness/compassion) in their childrearing values. Honesty, kindness, self-esteem and being polite/respectful were among the most highly endorsed values by fathers and mothers in both samples. At the group level, fathers' and mothers' relative orderings of childrearing values did not differ (e.g., values considered to be highly important by mothers were also considered to be highly important by fathers)—and this finding replicates across samples. At the family level, father-mother agreement (i.e., father-mother by-person correlations) is moderate on average (sample medians=+.34 and +.42, ps < .05), but agreement between partners showed striking variation (range= -.25 to +.90). Interestingly, parents of boys demonstrated greater levels of father-mother disagreement in their relative rankings of child-rearing values when compared to parents of girls. Although this finding was not replicated in Sample 2, these differences nonetheless emphasize the possible presence of variations within families that are not as clearly observed at the group level. This underscores the importance of examining value differences related to parent and child gender at both the group and family levels. Finally, parents' education level related to the values endorsed by parents: college graduates (both fathers and mothers) ranked "kindness and compassion" and "curiosity" as more important for their children than "politeness" and "obedience" relative to parents with less than a college degree.

Together, findings highlight large variations in childrearing values across individuals and father-mother pairs, but in the context of shared patterning when ordering values in aggregate across samples. Inter-individual differences in agreement about important values to instill in children may affect the co-parenting relationship and childrearing practices. Further, this study emphasizes the critical need for scientific replication, highlighting the need to validate findings across different samples.

P1-H-179 - A change in perspective: The role of walking in gaze and point following between 6-18 months of age

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Details

It has been argued that infants' motor development provides a "curriculum for learning" by providing the right visual input at the right stage of development (Smith, et al. 2018). An example of this is children's use of social signals. Whereas young children predominantly see faces (Jayaraman et al, 2015), their visual input later shifts with their ability to crawl and walk and hands become more prominent (Fausey et al, 2016). Children's understanding of social-communicative signals, such as gaze and point following follows this trajectory: Children learn about gaze before they are able to move on their own, once they start crawling and walking, hands become more prominent in their daily life, and children learn to follow pointing.

In the current study, we investigated the effects of infants' motor development on their use of social signals in a controlled environment in a sample of 6-18-month-old children (N=26). In a within-subjects design, we presented children with five different videos of an actor greeting the child, and subsequently engaging in five different combinations of referential signals towards one of two objects: (1) Gaze only, (2) pointing only, (3) matching gaze and pointing, (4) mismatching gaze and pointing, and finally, (5) a reaching movement towards the object. We hypothesised that children's ability to walk and/or crawl, and the resulting shift in perspective, predict children's use of social and referential signals, both towards the agent's head and their hands, as well as the object cued by the referential signal (compared to a competitor object).

Data collection is currently ongoing, and preliminary descriptive and statistical analyses are provided. Children's gaze shifts from head to hands and to the objects can be identified in the time series plot in Figure 1, difference scores of their looks towards the target-competitor objects is presented in Figure 2. Including the interaction between Walking ability and Time Window significantly improved model fits predicting children's looks to hands ($\chi^2(2) = 6.37$, p=0.04) and faces ($\chi^2(2) = 11.84$, p=0.003), after controlling for changes Time Window up to the fourth order, even though Walking ability does not lead to significantly more or less looks to either location across conditions (Hands: $\Delta M_{Walking(Y-N)} = 0.01$, SE=0.02, z=-0.405, p=0.69, Face: $\Delta M_{Walking(Y-N)} = 0.02$, SE=0.10, z=-0.164, p=0.87). Looking at their identification of the target object from the competitor, including children's Walking Status in interaction with Condition and Time Window improved model fit even after controlling for age ($\chi^2(10) = 20.17$, p=0.03) beyond a model controlling for Age in these interactions only. However, once again, contrasts between walking and non-walking children lead to increased, but statistically not significant gaze following ($\Delta M_{Walking(Y-N)} = 0.005$, SE=0.02, z=-0.227, p=0.82)).

P1-H-180 - Cross-cultural differences in the relationship between maternal socialization and infant helping in Uganda and the UK

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Details

One of the earliest forms of prosocial behaviour to emerge in human development is instrumental helping, which has been defined as actions intended to facilitate the acquisition of another individual's goal by acting on their behalf (Dahl, 2015). Although most studies focus exclusively on Western samples, a small number of studies have examined cross cultural variation in helping in early infancy (0-24m). These cross-cultural studies have found that infants from all samples engaged in instrumental helping, but there was variation in the likelihood or frequency of helping across cultural contexts (e.g. Callaghan et al., 2011; Giner Torréns & Kärtner, 2017; Köster et al., 2016). Parental attitudes and practices vary across cultures (Keller, 2007), yet the role that parental attitudes and practices take in shaping the emergence of early helping across different cultural contexts is not well understood. We took a longitudinal, cross-cultural approach to investigate maternal socialisation of early helping. Participants were mother-infant dyads from the UK (43 infants: 21 female, 22 male) and Uganda (39 infants: 22 female, 17 male). We examined societal variation in mother's helping-related parenting practices towards 14- and 18-month-olds (Study 1) and infants' actual helping in an experimental 'out-of-reach' task at 18 months (Study 2). We then asked whether maternal parenting practices and socialisation goals predicted individual variation in infant helping (Study 3). In Study 1, we found that UK mothers scaffolded infant helping using a larger range of strategies than Ugandan mothers, but expecting an infant to help was more common in Uganda than in the UK. In Study 2, we found that the Ugandan infants were more likely than the UK infants to help their mother or an experimenter in a standardised helping task (Figure 1). Moreover, the Ugandan infants helped experimenters (but not mothers) faster than the UK infants – with the majority of Ugandan infants helping before explicit verbal cues of need or requests for help were uttered. In contrast to recent findings by Reschke et al., 2023, the identity of the adult in need (mother or experimenter) did not affect the likelihood of infants helping in either society. Finally, in Study 3, we found that the number of different scaffolding behaviours mothers employed positively predicted individual variation in infant helping at 18 months in the UK, but not in Uganda. In contrast, maternal alignment with relational socialisation goals at 11 months positively predicted infant helping at 18 months in the Ugandan but not in the UK sample (see Figure 2). These results indicate that early instrumental helping behaviour varies across societies and that maternal socialisation goals and scaffolding behaviours can shape infant helping in culturally-specific ways. To further our understanding of the emergence of helping in infancy we need to consider the socio-cultural context in which infants are raised by studying infant development in different societies.

P1-H-181 - Bridging social ties to brain wires: a longitudinal approach to neonatal task-free functional connectivity and early interactions

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Details

Background. Unravelling the intricate nature-nurture interplay during early development is pivotal in comprehending how the environment shapes development. The Perinatal Imaging in Partnership with Families project (PIPKIN, www.pipkinstudy.com) longitudinally explores the impact of family and environmental contexts on infants' cognitive and brain development, utilising High Density Diffuse Optical Tomography (HD-DOT) as the primary neuroimaging technique. Here we focus on task-free functional

connectivity, exploring the neonatal brain's intrinsic organization and its links to early social context. The social context profoundly shapes newborns' developmental trajectories, influencing neural functions and behaviour (Karmiloff-Smith, Thomas & Johnson, 2018; Johnson, 2011). Ostensive cues like gaze and touch, largely used in early caregiving interactions, foster social learning from early stages (Farroni et al., 2004; Della Longa et al., 2021) and potentially contribute to differences in the connectivity of the social brain network. For instance, fMRI studies found children's intrinsic brain connectivity to be associated with eye gaze patterns (Kuboshita et al., 2020) and maternal touch frequency during parent-child interactions (Brauer et al., 2016). Additionally, infant fNIRS research associates Default Mode Network connectivity during rest with maternal sensitivity (Chajes et al., 2022) and infants' behavioural temperament (Kelsey et al., 2021). In the present work, we explore the associations between social engagement within early caregiver-infant interactions at 1 month and task-free functional connectivity at the same age, as well as its changes over the first month of life. Crucially, we investigate the potential specificity of these within social vs control networks.

Methods. We conducted longitudinal assessments in participants' homes to ensure ecological validity and minimize drop-out, in a UK cohort. During the neonatal phase of the PIPKIN study infants were assessed up to three times within the first 6 weeks of life: prioritising, where possible, a home visit around 1 week of age, 2 weeks of age and 1 month of age. For the current study, participants who contributed data were aged 2-10 days (N=20), 9-24 days (N=21) and 26-47 days (N=22). HD-DOT is used to gather task-free functional connectivity data, employing a system covering bilateral frontal and temporal brain regions. Participants are asleep and held by the experimenter during data acquisition. At 1 month, 5-minute caregiver-infant interaction is videorecorded and later coded offline for gaze and touch behaviours.

Results. Initial results show task free functional connectivity to be significantly lower in the social (pSTS, TPJ, frontal areas) vs control (homologous precentral and postcentral motor areas) network, with the lowest values observed when the seed is in the right hemisphere *(Fig. 1)*. Individual differences in functional connectivity changes over time are observed, along with high variability in behavioural social engagement during parent interactions at 1 month, that have currently been coded for a subsample depicted in *Fig. 2*. Forthcoming results on the association between task-free functional connectivity changes and interactive behaviours will be presented, holding potential for offering insights into the early dynamics of brain development.

P1-H-182 - How children aged 1-10 years react to retributive and restorative punishment

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Details

We investigated the early emergence of human understanding of punishment dynamics and its development in childhood. We focused on the distinction between retributive justice and restorative justice, asking whether and when a preference for the latter would emerge. Whereas retributive justice is driven by the motive of inflicting costs over the transgressor, restorative justice is driven by the need of repairing the damage caused to the victim. Prior research has reported that adults tend to prefer restorative over retributive punishers and the same proclivity has been observed in children starting at

age 4.
In the current research, we tested if this preference might originate even earlier, in the second or third year of life, and how it develops during childhood. To this aim, we included a sample of Italian 14- to 21-month old infants (N=16) and a larger sample of Italian children aged 3 to 10 years (N=256). We presented participants with computer-animated events depicting a moral violation (two protagonists both built a tower piling up three blocks, when one of them knocked over the tower of the other). In a first scenario, the event was followed by a restorative punishment (the punisher forced the transgressor to reconstruct the victim's tower); in a second scenario, the event was followed by a retributive punishment (the punisher destroyed the transgressor's tower). These acts were performed by two distinct agents, a restorative and a retributive punisher. Infants were then presented with the two punishers, displayed on screen first and then on a tray. Their preferences were inferred from what punisher they looked at first while on screen, and from what punisher they chose to manually pick up from the tray. Older children were instead presented with the two punishers on screen and asked, "Which one do you prefer?" and "Which of the two acted better?".
We found moderate positive Bayesian evidence that our infants did not show a preference, BF_{01} =3.34. However, although at the group level infants did not show a preference, we found evidence of a positive association between first look and manual choice responses, χ^2=4.67, *p*=.031 (Fig.1), suggesting the possibility that already at this very young age children might start expressing individual differences in their reaction to retributive vs. restorative justice. Next, focusing on older children, we found that the percentage of children who preferred the restorative punisher over the retributive one shifted from 30% at age 3 to 90% at age 10 (Fig.2), with a preference for the restorative agent reliable higher than chance level emerging at age 5, *p*=.001. A similar trend was found when analyzing the responses to the question of "who acted best".
Together, these results suggest that at the age of 3 years, children focus their judgments about punishment on the consequences for the transgressor, and then, between the age of 4 and 5, the focus shifts on the compensation of the victim, in continuity with the tendency found in adults. These results have deep implications for our knowledge about the roots and development of punishment evaluation.

P1-H-183 - The role of parental conversations and preschool experience on infants' understanding of fairness

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Details

Background: Already in the first year of life, infants demonstrate a sophisticated understanding of fairness, detecting fair and unfair resource distributions and expecting distributions to be equal. However, there is limited research on individual variations in early fairness reasoning and the factors contributing to suchvariations. This study explored the influence of two social factors on infants' evaluations of resource distributions: 1) parents' conversations about morally relevant situations and 2) infants' preschool experience.

Method and coding: Fifty-four 18-month-old children (30 females, 24 males) participated in a non-verbal distributive fairness task. Infants sat in their parent's lap in front of an eye-tracker and watched

an animation featuring a mouse, two monkeys and a y-shaped tube. The mouse carried a plate with four bananas, entered the tube four times, each time carrying a banana. Finally, the infants were presented with a split screen showing an unequal and an equal distribution of bananas (Fig 1). We coded the infants' total looking times at both images in the split screen and calculated a differential looking score (DLS) to assess their preference for the unequal outcome.

Additionally, the children and one of their parents (40 mothers, 13 fathers) engaged in a task involving discussions about moral pictures, which were selected based on Moral Foundations Theory. To evaluate parents' morally relevant conversations, they were provided with ten pictures illustrating five moral domains (i.e., care/harm, fairness/cheating, loyalty/betrayal, authority/subversion, and sanctity/degradation) and were videotaped interacting with their infant for ten minutes. We then calculated the frequency of conversations related to each moral domain. We also asked the parents if their child attended preschool on a regular basis, and 12 infants did.

Results: We found that 35 out of 54 infants looked longer at the unequal outcome ($p < .05$) indicating an expectation a fair distribution. Parents' conversations covered all five moral domains, with the most discussions about sanctity/degradation ($M = 3.30$) and the least about loyalty/betrayal ($M = 2.68$). Infants' DLS scores showed no significant associations with parents' moral conversations. However, attending preschool had a significant effect, $t(52) = 2.19$, $p = .033$, $d = .715$, indicating that children who attended preschool performed better on the fairness task compared to those who did not.

Discussion: The study contributed to existing research on infants' ability to reason about distributive justice. It suggests that interacting with peers may positively influence this ability, whereas verbal input from parents did not seem to contribute to individual differences in this aspect of moral reasoning.

P1-H-184 - Structured activities facilitate grandparent and grandchild enjoyment of triadic videochat interactions

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Details

Bronfenbrenner's ecological systems theory emphasizes the influence of various environmental systems on human development. The microsystem is usually thought of as immediate environments that an individual experiences directly, but videochat now allows children and remote family members to build virtual connections in ways that were not possible even 10 years ago. Close grandparent-grandchild relationships benefit both parties' health and psychological well-being. Despite the importance of these relationships, many grandparents who want to connect do not do so; 67% report liking the idea of video chatting with grandchildren but only 28% did so regularly. One possibility is that low child engagement is a frustration that leads to less frequent videochats and lower levels of enjoyment. In prior research (citation blinded), we found that videochat frequency and the variety of activities they engaged in during videochats were predictive of grandparent enjoyment of the videochats and grandparent-reported

closeness to their grandchild. Therefore, structuring videochat interactions to promote reciprocal interaction and shared focus may lead to more engaging and enjoyable experiences that promote feelings of enjoyment for all members of the triad (parents, children, grandparents).

We directly compared two approaches (reading and play) in which we instructed grandparents on how to engage in videochats with young grandchildren (18-36 months of age). Our hypothesis is that structured videochat will increase children's and grandparents' enjoyment of videochat compared to a control condition (no instructions). Specifically, we expected that structured playful activities would foster the highest levels of enjoyment at this age. Our work is funded by an NIH R15 grant and is pre-registered at OSF and clinicaltrials.gov.

Families (n=37) rated their enjoyment of videochat interactions at the start and end of the study, and submitted 11 Zoom recordings (1 baseline, 9 after instructions, 1 final) of virtual interactions with one another. Here we report results on self-reported enjoyment; behavioral coding of children's engagement is ongoing and will be ready by the time of the conference. We analyzed enjoyment scores in several 2 (time: start vs. end) X 3 (condition: reading vs play vs control) repeated-measures ANOVAs, one for each outcome variable (parent, child, and grandparent enjoyment). Results showed significant time X condition interactions for grandparent enjoyment, $F(2,33)=11.21$, $p<.001$ as well as child enjoyment, $F(2,32)=4.05$, $p=.027$. Specifically, enjoyment increased from start to end of the study for the reading condition compared to the control and play conditions (see Figure 1). There were no effects for parent enjoyment.

These results show that structured activities facilitate grandparent and child enjoyment of videochat interactions. Despite our predictions that playful activities would be best at the age of 18-36 months, it was the reading condition that fostered higher levels of enjoyment over time. These results have implications for families' use of videochat technology to connect across distance, and suggest that the use of videochat may actually allow for remote grandparents to be a part of a new sphere of ecological influence (a *virtual* microsystem) from what Bronfenbrenner identified originally.

P1-H-185 - Division of labor between coparents during the transition to parenthood

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Details

The transition to parenthood is characterized by the emergence of the coparenting relationship, defined as the quality of coordination between parents in their new, renegotiated roles and in their parenting

responsibilities, which ensures the well-being of their child and family (Feinberg et al., 2012). While research shows that both partners have now become increasingly involved in childcare (Gallegos et al., 2019), other results suggest the continuation of a gendered division of labor during the first year post-partum. Childbearing mothers remain primarily responsible for child care and domestic matters, while their partners often take on secondary roles (Riina & Feinberg, 2012). Partner distinctions also emerge in their coparenting experience during the transition to parenthood (Sheedy & Gambrel, 2019). The theoretical framework of self-determination theory may provide a deeper understanding of the emerging coparenting during the transition to parenthood, by considering the quality of the relationship from the perspective of satisfaction and thwarting of the basic psychological needs, namely of autonomy, competence and relatedness (Deci & Ryan, 2000). This study's objective was to determine whether the link between new parents' coparenting division of labor and their perceived basic needs support/thwarting differs between partners during the transition to parenthood.

Primiparous couples ($N_{childbearing\ mothers}$ = 320 and $N_{partners}$ = 206) of 6-month-olds completed online questionnaires, including the *Interpersonal Behaviors Questionnaire* (Rocchi et al., 2017) and the *Coparenting Relationship Scale* (Feinberg et al., 2012).

Results indicated that the more childbearing mothers feel their autonomy is thwarted, the less they perceive a good coparenting division of labor (r=-.34,p=.00), but this is not true for partners (r=-.17,p=.06; significant correlational difference:Z=-2.01,$p\leq$.05). This suggests that the less childbearing mothers perceive that their partner lets them act on their own volition and supports their choices in parenting (Ryan & Deci, 2017), the more unhappy there are with how the domestic and childcare labor is divided between them. Second, the more childbearing mothers feel their competence is supported, the more they perceive a good division of labor (r=.32,p=.00), but this is not true for partners (r=.11,p=.25; significant correlational difference:Z=-2.40,$p\leq$.05). This suggests that the more childbearing mothers feel that their need for competence is supported by their partner (i.e. the ability to feel efficient and confident in achieving one's own goals; Ryan & Deci, 2017), the happier they are with the division of labor. Third, the more both parents perceive that their relatedness is supported, the better they perceive the division of labor, yet childbearing mothers (r=.38,p=.00) feel this more strongly than partners (r=.22,p=.04; significant correlational difference:Z=2.01,$p\leq$.05). These results mean that the more their need for relatedness is supported by their partner (i.e. feeling connectedness and belonginess to others and receiving warmth from significant people; Ryan & Deci, 2017), the more satisfied they are with division of household and childcare labor.

These results show distinctions between parents in their experience of coparenting and the extent to which they perceive their basic needs as supported/thwarted in their couple relationship, especially concerning the division of household labor early in the transition to parenthood.

P1-H-186 - Cross-cultural differences in infant play behavior in the UK and Uganda

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Details

Play is pervasive across social species and in humans and play in infancy is important in the development of numerous social and cognitive skills, such as problem-solving (Dansky & Silverman, 1975), language development (Stagnatti & Unsworth, 2000), and learning about adult expectations and social norms (Burriss & Tsoa, 2002). Despite a strong theoretical foundation for how play influences infant development, the current empirical evidence on infant play falls victim to the persistent Western sampling bias that characterises developmental psychology (Nielson et al., 2017). The few cross-cultural studies on infant play thus far have demonstrated how play behaviour can be influenced by different parenting styles across cultural groups (Lamm et al., 2015; Tamis-LeMonda et al., 1992; Bornstein et al., 1999). This study aims to contribute to our understanding of variation in infant play in two samples of infants living in the UK (n=53) and Uganda (n=44) . Critically, the parenting practices and maternal socialisation goals of these two samples differ (Holden et al., 2022); mothers in the Ugandan sample aligned more closely with relational socialisation goals, whereas mothers in the UK sample aligned more closely with autonomous socialisation goals. In this study, we use behavioural data, consisting of instantaneous scan samples of infant and caregiver activities from full-day focal follows when infants were 3- and 6-months-old. We found that frequency of play increased from 3 to 6 months of age in both samples, and play was more frequent in the UK sample compared to the Ugandan sample. When focussing on the type of play that infants engaged in at 6 months, elevated proportions of social object play were observed in the UK sample. This was not due to availability or interest in objects, as there was no difference between UK and Ugandan infants' frequency of object play overall when considering social and non-social object play together. Rather, high levels of social object play in UK infants seemed to reflect the importance of face-to-face and object mediated interactions within distal parenting styles and autonomous goals (i.e. UK mothers prioritised engaging in social object play with their infants). Ugandan infants also spent less of their time in social play (overall, and with their mother) compared with UK infants. As this did not fit with the emphasis on social connectedness that characterises relational socialisation goals, we considered whether mothers in our Ugandan sample may have had less time available to play with their infants, given their reliance on subsistence farming. However, using time budgets derived from the scan data, we found no evidence that maternal availability for play (e.g. time not engaged in essential tasks) varied significantly between UK and Ugandan mothers. Overall, whilst some findings aligned with predictions derived from maternal socialisation goals, others did not and require further investigation to fully understand. This study highlights the need to directly measure infant behaviour in diverse cultural settings to understand how and why play behaviour in infancy varies, before examining how variation in early play influences later infant development.

P1-H-187 - Infants' social attention preferences revealed using simultaneous social and nonsocial videos

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Details

Studying infants' early visual perception in an ecologically valid but experimentally controlled way is challenging because, in the real world, infants have varied visual experiences with dynamic social and nonsocial stimuli competing for their attention. To capture some of this natural complexity, researchers developed eye-tracking paradigms that simultaneously present complex stimuli. For example, toddlers (12-43 months) prefer dynamic social stimuli (videos of people) relative to simultaneously presented dynamic nonsocial stimuli (Pierce et al., 2011). Yet, only one study used this method of presenting social and nonsocial videos side-by-side in younger infants, reporting a preference for social stimuli by 2 months (Maylott et al., 2021). However, this study used only one social/nonsocial video pair, therefore, while providing initial support for an early social preference, it remains unknown whether this preference is generalizable to other naturalistic stimuli.

In the current study, we measured healthy, full-term, U.S. 2- to 14-month-olds' (*N*=74; including 35 females, 1 Asian, 10 Black, 42 Hispanic/Latine, 17 non-Hispanic White, and 8 multiracial infants) looking times to 8 pairs of 10- to 15-second social and nonsocial silent video pairs (see Figure 1 for examples), with a Tobii TX300 eye tracker. Videos were similar in low-level features (e.g., contrast, movement, complexity), and depicted people of various genders, ages, races, and ethnicities.

Overall, infants looked longer to social than nonsocial stimuli, $F(1,128)=7.98$, $p<.001$, $\eta_p^2=.293$, and looked longer with age (to both stimulus categories), $F(4,128)=12.87$, $p<.001$, $\eta^2= 287$. We detected a stimulus category (social/nonsocial) x age interaction, $F(4,128)=14.04$, $p<.001$, $\eta_p^2=.200$, in which infants showed stronger social preferences with age (Figure 2a). Together, these findings suggest infants may have an overall preference for dynamic social relative to nonsocial stimuli that strengthens across the first year, potentially reflecting growing social learning (Zeng et al., 2023), as well as improving attention regulation capacities enabling them to disengage from salient low-level distractions (Pomaranski et al., 2021).

We found an age x video-pair-type (8 different videos) interaction, $F(4,94)=3.46$, $p<.001$, $\eta_p^2=.128$, which revealed some video pairs elicited increasing social attention with age, while others elicited decreasing social attention with age (see Figure 2b for examples). We explored data at the trial level to understand the unique developmental patterns captured by each stimulus pair. For example, we found, at some ages, infants attended more to hands with objects than faces, so this may reflect a distinct type of social preference (Suarez-Rivera et al., 2019) underscoring the need to use varied types of social stimuli.

Our findings underscore the importance of improving internal and external validity by using this multi-trial approach to capture infant social attention (Byers-Heinlein et al., 2022). Developing better measures of infants' social attention is necessary for understanding typical development, and lays a foundation for predicting potential disorders (Falck-Ytter et al., 2023).

P1-H-188 - Language and socialization skills of young children with Cancer

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Details

Background: Previous studies have noted challenges in social and neurocognitive functioning in survivors of childhood cancer, with young age at diagnosis a particular risk factor. There is a particular gap in the literature regarding the associations between parent reports and clinical assessment of children's language skills, and children's language and socialization skills. Examining these relationships in young children may aid in the identification of early intervention targets for specific aspects of children's socialization and could lead to increased provision of information to parents about practical strategies to support children's early language development. The present study had two aims: 1) examine the correlation between parent reports of children's language skills and the clinical assessment to determine if speech language pathologist (SLP) services are needed; and 2) investigate the associations between children's expressive and receptive language skills and the overall domain and subdomains of socialization.

Methods: Children with cancer (N = 47, M_{age} = 2.01 years, 47% female) completed clinical developmental assessments to assess the need for intervention services. As part of the evaluation, parents completed the Vineland Adaptive Behavior Scales, Second Edition, including reports of their child's interpersonal relationships, play and leisure, and coping skills in addition to their expressive and receptive language skills. A chi-square test was used to examine the relation between parent reports of their children's language skills and whether the child was referred to a SLP for intervention services. Furthermore, regression analyses examined associations of the children's language skills, expressive and receptive, and the subdomains of socialization (child's interpersonal relationships, play and leisure, and coping skills) and the overall socialization domain while controlling for child's age, sex, and date of diagnosis.

Results: For parents who reported no language concerns for their children, they were disproportionately recommended for language services, $X^2(1, N = 125) = 4.65$, $p = .031$. In terms of the relation between children's expressive and receptive language and the overall domain of socialization, only expressive language (b = .50, $p = .004$) was significantly associated with children's socialization skills. In terms of the subdomains of socialization, expressive language (b = .67, $p < .001$) was significantly related to interpersonal relationships, and receptive language (b = .39, $p = .024$) was significantly associated with play and leisure. There were no statistically significant relations between either expressive or receptive language and the children's coping skills.

Conclusions: Findings highlight that parents of young children may underestimate the child's need for language intervention services. Moreover, given the differential relations between expressive and receptive language skills and various aspects of children's socialization, it might be important to target both aspects of language in early intervention programs to support the overall development of children's social skills, an outcome that children with childhood cancer tend to have deficits in.

P1-H-189 - RSA suppression and social-communication during the first year of life.

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Details

Respiratory sinus arrythmia (RSA), a measure of parasympathetic nervous system activation, has been linked to socioemotional development (Porges, 2007; Thayer & Lane, 2000). Specifically, reduced or "suppressed" RSA in response to stressful events has been linked to joint attention, gesture use, and other social-communicative behaviors (Patriquin et al., 2011; Bradshaw & Abney, 2021). Interestingly, differences in RSA have been found both in children diagnosed with autism spectrum disorder (ASD) (Patriquin et al., 2011) and in infants from lower SES backgrounds (Jones-Mason et al., 2018). However, little is known about interactions between sociodemographic risk and physiological regulation within the context of ASD. The present study addresses this gap by examining associations between RSA suppression and social-communication in an infant sample possessing a range of SES and genetic likelihood for ASD. The study aims to examine the relationship between RSA suppression, neurodivergence, and SES in predicting social-communication skills within the first year of life.

Participants included 61 infants (n=30 female) at elevated or low genetic likelihood for ASD as part of a larger longitudinal study. Data from the 6- and 12-month visits are included. At 6-months, infant cardiac data was collected during a modified still-face procedure. Average RSA was calculated during the Play and Ignore phases of the still-face procedure. Infants were dichotomized as either an RSA Suppressor (decrease in RSA from Ignore to Play phase) or RSA Non-Suppressor (increase or no change in RSA between phases) groups. At 12-months of age, the Communication and Symbolic Behavior Scales – Behavior Sample (CSBS-BS; Wetherby & Prizant, 2002) was administered to obtain a measure of social-communication skills. The CSBS-BS yields an overall Total score, and three domain scores (Social, Speech, and Symbolic). Clinical best estimate (CBE) diagnoses were determined to differentiate participants into neurotypical (NT; no identified developmental delay and/or ASD; n=38), and neurodivergent (ND; n=23) groups. SES was measured by calculating the family's percentage of the Federal Poverty Level (FPL) at study entry.

ND infants (*M(SD)*=2.42(1.27)) possessed lower SES in comparison to NT infants (*M(SD)*=3.75(2.07); $t(54.99)=-3.00$, $p=.004$). Very few infants were Non-Suppressors, and the proportion of infants who were RSA Suppressors did not differ by CBE diagnosis (ND n=2, NT n=7; $X^2(1, N=55)=0.40$, $p=.53$). Regression models were used to predict CSBS scores from an interaction term between CBE diagnosis and SES. No significant interactions were found (see Figure 1).

Results indicate that infants who exhibit typical patterns of RSA suppression show no differences in social-communication scores even when accounting for SES or CBE diagnosis. Thereby, findings suggest that healthy physiological regulation may serve as a protective effect for infants at greater risk for social-communication deficits. Within this sample, RSA Suppressors appear resilient to genetic and environmental stressors that may impact their development of social behaviors. Because there are few Non-Suppressor infants, we do not yet understand how atypical physiological regulation in this sample impacts social-communication outcomes. Data collection is ongoing, and increased sample sizes will be utilized in future analyses to further strengthen these findings.

P1-H-190 - Infant social experience in different cultural and socio-economic contexts: a comparison between UK, South Africa, and Malaysia

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Details

Child development is culturally shaped through daily interactions with caregivers in their immediate environment. However, even within the same cultural context, social and economic differences can affect parent-infant interactions and later children development (Bornstein & Bradley, 2014). Recent research found that infants growing up in in a context of poverty and adversity, have lower levels of maternal caregiving behaviours, but similar levels of face-to-face contact compared to middle-class infants (Otto et al., 2017; Cooper et al., 2009). However, there is scarce evidence regarding the actual quantity of social stimulation infants receive, and whether this is related to cultural vs socio-economic differences. Here we compared mother-infant social engagement in 5 different populations from 3 different countries. These included one group from an urban middle-class setting in Reading, UK (R), two groups from South Africa (one from an urban middle-class in Stellenbosch (S), and one from Khayelitsha (K), an impoverished peri-urban settlement outside Cape Town), two groups from a sub-urban setting in Sibu, Malaysia (one from a middle-class (MM), and one from a low-class setting (ML)). Spot observations at 2-3 months postpartum were used to code the amount of time mothers spent: close to the infant; in a face-to-face position; in active social engagement with the infant during face-to-face contacts. Compared to MM and ML mothers, K mothers spent less time close to their infants, and S mothers spend less time close to their infants compared to ML. When close to the infants, both MM and ML mothers spent less time in a face-to-face position compared to K, S, and R. However, both K and ML/MM mothers spent less time than R and S socially engaging their infants. These results show both similarities and difference between and across cultures and might shed new lights on the contribution of cultural and socio-economic differences in shaping parent-infant interactions and later infant development.

P1-H-191 - Individual differences in infants' prosocial behaviors across cultures

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Details

Infants exhibit prosocial behaviors during the first year of life, engaging in activities such as passing on objects to others, sharing food and toys, and cooperating with parents when getting dressed (e.g., Hammond et al., 2017). Despite these observable behaviors, it remains unclear how proximal factors are related to infants' prosocial behaviors (Brownell, 2016; Dahl, 2018). To address this gap, the current study examined the frequency of infants' prosocial behaviors in relation to (1) demographic factors (age, premature days, gender, caregiver education), (2) parental cultural values (individualism versus collectivism tendencies), (3) parental moral-related characteristics and beliefs (justice sensitivity, expectation of prosocial age, curiosity in infants' mental states), and (4) infant daily behavior (frequency of social games, screen time, frequency of book reading).

The data was from a spin-off project of the ManyBabies 4 project, which examined individual differences in infants' social preferences and prosocial behaviors by using a large sample of infants from diverse cultural contexts. The current study included a total of 539 infants (50.4% girls) from 11 countries (Mean age = 8.63 months, SD = 1.55). More data will be included when all labs complete their data uploading. Caregivers (333 mothers, 45 fathers, and 161 unreported identities) filled out a set of questionnaires including a family background survey to measure demographic factors, the Infant Prosocial Behavior-Parent Interview (Breeland & Henderson, 2021) to measure the frequency of infants' prosocial behaviors (i.e., 'How often does your baby demonstrate helping/comforting/sharing/cooperating behaviors') and their parental expected age for infants to show prosocial behaviors, the Horizontal and Vertical Individualism and Collectivism II (Matsumoto et al., 1999; Triandis & Gelfand, 1998) to measure parental cultural values, the Justice Sensitivity Short Scales (Baumert et al., 2014) to measure parental justice sensitivity, and one subscale of the Parental Reflective Functioning Questionnaire (Pajulo et al., 2018) to measure parental curiosity in infants' mental states.

We used a multi-linear regression model to analyze the predictors of the frequency of infants' prosocial behaviors (n = 94). After entering all factors step by step in the model, the frequency of infants' prosocial behaviors was positively related to infant age (β = 0.32, p = .002, 95%CI [0.002, 0.01]), parental curiosity in infants' mental states (β = 0.24, p = .018, 95%CI [0.04, 0.42], see Figure 1), and the frequency of playing social games (β = 0.28, p = .009, 95%CI [0.06, 0.37], see Figure 2), and was negatively related to infant premature days (β = -0.23, p = .023, 95%CI [-0.07, -0.01]) and caregiver education (β = -0.20, p = .039, 95%CI [-0.25, -0.01]). Together, these findings suggest that infants' prosocial development is related to the social environment created by their caregivers. One limitation of the study is that only survey data is used. We are currently coding observations of real-world parental behaviors and will integrate the observational and survey-based measures to further validate the correlations between parental socialization and infant prosocial behaviors.

P1-H-192 - Exploring infant brain sensitivity to human and non-human interactive contingency

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Details

Objective: Live social stimuli play a crucial role in human perception, yet it remains unclear whether the brain processing of live interactive social stimuli differs significantly from that of non-interactive social stimuli. Building on our previous study revealing increased activation in the right temporoparietal junction (TPJ) region in response to contingent responsiveness in 6- to 8-month-old infants during real-life interactions (Hakuno et al., 2020), the current study investigates brain activity in 6-month-old infants across the right temporal (temporoparietal junction: TPJ and superior temporal sulcus: STS) and frontal (medial prefrontal cortex: mPFC) regions in response to human and non-human contingent stimuli during social interactions using fNIRS.

Methods: 6-month-old infants were divided into three groups: human-positive (N = 25), human-negative (N = 24), and non-human (N = 25) conditions. Throughout the fNIRS recording, an experimenter served as a social partner, interacting with an infant using picture books and puppets in a semi-structured context. Experimenter speech and gestures were roughly scripted for consistency. In the human-positive condition, the experimenter contingently smiled immediately after infants referred to her face; in the human-negative condition, the experimenter stopped smiling contingently. In the non-human condition, a light-emitting device, which was on the experimenter's head, emitted visible light contingently. During each session, two experimental trials, contingent (C) and non-contingent (NC), were presented randomly in an event-related design. In the C trial, the experimenter responded contingently to infant gaze with no temporal delays. In the NC trial, responses were delayed by 3 s. During the baseline, the experimenter maintained the same behavioral approach, with the exception that neither contingent nor delayed responses were executed.

Results and Conclusions: A cluster-based permutation test revealed greater hemodynamic response in the right TPJ region for the C trial than the NC trial only in the human-positive group ($p < 0.01$). These findings align with the previous block-design study showing early responsiveness of the right TPJ region to social contingency in the first year of life. While no clear trial-specific responses were found in the frontal region for the human-positive condition, increased mPFC activation from baseline was observed in the human-negative condition ($p < 0.01$). Conversely, no increased activation for the C trial compared to the NC trial was found in either the right TPJ or mPFC regions in the non-human condition. These results suggest the early involvement of the right TPJ and mPFC regions in processing highly communicative human behavior during natural social interactions. Given that the TPJ and mPFC are recognized core areas of the mentalizing network in human adults, heightened sensitivity exclusively to contingent human stimuli during infancy is presumed to play a pivotal role in the development of social cognition.

P1-H-193 - 6-month sitting associated with 18-month social communication for infants at an elevated likelihood for ASD

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Details

Background

As infants achieve motor milestones such as sitting, crawling, and walking, their interactions with caregivers and the environment undergo significant changes[1]. Gaining control over posture and locomotion enables infants to interact more effortlessly with objects and people in their surroundings, fostering increased joint engagement[2] and social interaction[3]. This lays the essential groundwork for the development of social communication skills. Infants at an elevated likelihood (EL) for autism spectrum disorder (ASD) exhibit greater motor delays within the first year of life compared to low likelihood (LL) peers. Growing research has shown that early motor delays not only predict later communication delays[4] but also ASD severity[5]. A recent study[6] found that early growth trajectories in postural and head control from 1 to 6 months predicted social communication skills at 24 months for infants with ASD. These motor processes precede the onset of independent sitting, which is concurrently associated with the onset of gestures and babbling for EL infants[7]. Independent sitting, an easily recognizable motor milestone, may serve as a useful predictor of social communication skills, with delays in its onset indicating a greater need for early intervention and developmental monitoring.

Objectives

This study aims to compare 18-month social communication and play skills between EL and LL infants who did and did not achieve independent sitting by 6 months of age.

Methods

Data were collected longitudinally from 67 full-term infants at 6 and 18 months. Infants were at an elevated likelihood (EL; N=30, 14 males) or low likelihood (LL; N=37, 20 males) for ASD. At 6 months, caregivers completed the Early Motor Questionnaire (EMQ) to assess motor skills, including their child's sitting ability. At 18 months, caregivers reported on their child's social communication and play skills using the Communication and Symbolic Behavior Scales-Caregiver Questionnaire (CSBS-CG).

Results

Within our sample, 23 (62%) LL infants and 11 (37%) EL infants achieved independent sitting by 6 months of age ($\chi^2(1) = 4.31$, $p < .05$). Two-way independent ANOVA modeling was used to explore differences in social communication and play skills among early and later sitters based on ASD likelihood status. EL infants scored lower, on average, than LL infants across all CSBS-CG domains (p's $< .05$). Significant interactions between sitting status and ASD likelihood were observed for two CSBS-CG domains: Gestures ($p = .03$) and Sounds ($p = .012$), with Words ($p = .06$) approaching significance. Post hoc tests revealed that EL-early sitters scored significantly higher, on average, than EL-later sitters across these three domains (p's $< .01$, see Figure 1). LL infants did not significantly differ across any domains of the CSBS-CG by sitting status at 6 months.

Conclusions

At 18 months, EL infants who achieved independent sitting by 6 months showed improved language comprehension, sound and word production, and increased gestures and symbolic object play. Early and later sitters within the LL group did not differ in social communication skills; however, symbolic object use was trending toward significance (p = 0.06). For EL infants, early independent sitting may serve as a protective factor against later social communication delays, suggesting that those who do not achieve this milestone by at least 6 months of age should be more closely monitored for other delays and may benefit from early intervention.

P1-H-195 - Use of corporal punishment by parents of infants in the US and Malaysia

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Details

Corporal punishment (CP), as defined by The Committee on the Rights of the Child (CRC Committee) is "any punishment in which physical force is used and intended to cause some degree of pain or discomfort, however light" (CRC Committee, 2006, p. 4). As of 2021, laws prohibiting parental corporal punishment have been enacted in 63 countries (Global Initiative to End All Corporal Punishment of Children, 2021). While legal prohibitions such as this has led to decreased use and decreased public support for corporal punishment in some countries, corporal punishment is still prevalent worldwide (Durrant & Ensom, 2012). Efforts to increase the number of countries adopting a legal standard of children's right to a violence-free upbringing would be well served by information aimed at understanding why some countries have yet to ratify or taken few steps to implement CRC (2007) guidelines. Two such countries are Malaysia and the United States. There is reason to believe that attitudes toward harsh discipline or corporal punishment may differ for parents from Malaysia and the United States. Given continuing global efforts to reduce parental use of corporal punishment, it is worthwhile to understand what factors may be related to parental use of corporal punishment and attitudes toward corporal punishment, including laws prohibiting corporal punishment.

Method

The sample consisted of 64 parents living in Malaysia and 72 parents living in the United States. All parents had at least one child between the ages of 8- and 30-months-old. All parents completed an adapted version of the Dimensions of Discipline Inventory (DDI; Straus & Fauchier, 2007).

Results

MANCOVA Comparisons between the two countries (Malaysia, US) on attitudes toward CP variables revealed no significant main effect for nationality group, Wilks's λ = .52; $F(2, 215) = 2.12$, *ns*. Within the Malaysian sample mothers held more positive attitudes toward CP than fathers, as did parents with more children, those who reported a stronger affiliation with their religion, and those who experienced higher levels of CP as children. However, in the US sample only ethnicity and childhood experience of CP were significant predictors. Participants of color and participants who experience higher levels of CP as children felt more positively toward CP.

A similar pattern emerged in predicting endorsement of laws limiting CP, with gender, religious affiliation and childhood experience of CP emerging as predictors in the Malaysian sample, and ethnicity and childhood experience of CP emerging as significant predictors in the US sample.

The results of this study suggest that parents from Malaysia and the United States are similar in their endorsement of the use of CP as a form of discipline during infancy. However, factors that account for individual differences in level of endorsement of CP within each country differ. This suggests that education campaigns to promote positive and alternative forms of discipline and respect for children's rights should be tailored to particular subgroups within each country to increase the effectiveness of such efforts.

P1-H-196 - Evaluation of a parenting program to promote growth-promoting parent-child relationships and children's healthy development in Hispanic families

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Details

The foundational role of parenting practices in a child's first three years is widely acknowledged for its significance and lasting impacts. Parenting interventions have become successful strategies in promoting positive parent-child interactions and children's healthy development. The focus of this report addresses the effectiveness of "Play With Me", a 12-week, relationship-focused, playful-learning program developed by the University of Texas at Dallas Center for Children and Families, delivered in multiple community sites for parents and their children under 4 years of age. Families served are predominantly Spanish-speaking (62.5%), originally from Latin America, many with low levels of formal education (40.6%) and household incomes. This study addresses the program's impact on parenting practices and efficacy and child development; it also addresses and implementation processes, focusing on the unique needs of a historically understudied population.

The "Play With Me" curriculum includes weekly discussion topics shaped by challenges in parenting voiced by the parents we serve and by the center's developmental specialists and faculty. The program seeks to enhance parenting knowledge, reduce stress, and support systems. Emphasis is placed on promoting children's language development, self-regulation and social skills—each important for school readiness. The program has developed a culturally appropriate curriculum, incorporating playful-learning activities encouraging children to explore, ask questions, regulate emotions and behavior, and connect their interests with their world.

The significance of this research lies in its potential to advance our understanding of culturally appropriate parenting supports and their impact on foundational elements of early child development in the population we serve. By exploring factors associated with varying program outcomes, the study aims to provide insights for more responsive support systems for this growing population.

Study participants include parents and their children enrolled in the program in 2023 through Spring 2024 (n = 80), a comparison group of parents (n = 50) recruited from the program's waitlist and from

public library branches that serve a similar demographic. A pre-post/comparison group design is being used. Measures include the Parent Play Questionnaire, Child Adjustment and Parent Efficacy Scale, the Brief Infant–Toddler Social and Emotional Assessment, and ratings of parent and child interactions from video recordings in the families' homes of a parent-child storybook procedure. Preliminary findings based on pre-post comparisons of Play With Me participants in the Spring of 2023 (n = 32) indicate significant improvements in parent's involvement in play with their children, $t(31)=-1.91$, $p=.03$; $M_{pre}= 4.00(.84)$, $M_{post}=4.24(.69)$, reports of parents' enjoyment of parent-child play $t(31)=-2.17$, $p=.01$; $M_{pre}= 4.35(.83)$, $M_{post}=4.59(.59)$, and parents' positive attitudes toward play with their child $t(31) = -2.64$, $p=.006$; $M_{pre} = 4.03(.68)$, $M_{post} = 4.26(.39)$. Regarding child outcomes, parents reports of child problem behaviors decreased, $t(31) = 1.79$, $p=.04$; $M_{pre} = 1.57$ (.26), $M_{post} = 1.49(.33)$. Data collection for the Fall 2023, Spring 2024 and comparison group is ongoing.

Results of all planned comparisons will be presented. Also program effectiveness will be examined in relation to parent characteristics and children's developmental needs identified by ASQ-3 screening. The results will contribute to the growing effectiveness of this relationship-focused program for these families living in North Texas of the U.S.

P1-H-197 - Support for mothers' basic psychological needs in childbirth predicts parental self-efficacy and parent-infant relationship quality

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Details

Many women report dissatisfaction, or even trauma, associated with their childbirth experience. Dissatisfaction with childbirth predicts anxiety and depression while maternal well-being has positive impacts on parent-child relationship quality (Coleman & Karraker, 1998; Richter et al., 2018). Because childbirth is emotionally, hormonally, and physically transformative, promoting women's well-being in the perinatal period likely amplifies the effects on mother and child.

Basic Psychological Needs Theory (BPNT; Deci & Ryan, 2008), provides an excellent framework for investigating childbirth satisfaction. According to BPNT, humans flourish only if their basic needs are met by the social environment. These needs are *autonomy* (self-directedness), *relatedness* (belonging), and *competence* (self-efficacy). Being supported in these basic psychological needs by care providers during childbirth likely benefits mothers' parenting and parent-child relationships.

To address this question, mothers filled out surveys at three time points: T1, 36 weeks pregnant; T2, 4 weeks postpartum; and T3, 12 weeks postpartum. We assessed parental self-efficacy (PSE; Crnec et al., 2008) and depressive symptoms (Cox et al., 1987) at both T1 and T2. At T2, we also asked about mothers' birth experiences. Measures included the Basic Psychological Needs Satisfaction and Frustration Scale (BPNSFS; Van der Kaap-Reeder et al., 2020), with some slight changes to apply to the context of childbirth.

A total of 69 first-time mothers submitted surveys for both T1 and T2. Mothers lived in the U.S., were between 19-40 years old (M = 28.80), and were 84% White, 9% Black, 5% Asian, 1% Hispanic or Latinx.

A linear regression with postnatal PSE as IV, BPNSFS as DV, and prenatal PSE, prenatal depression, and postnatal depression as controls accounted for significant variance, R^2 = 0.60, F (4, 68) = 23.93, p < 0.001. The BPNSFS scale was marginally significant in predicting postnatal PSE, β = 0.17, p = 0.09. To examine this further, we conducted a second linear regression using the subscales representing the three basic psychological needs as DVs. This regression also accounted for significant variance, R^2 = 0.64, F (6, 68) = 18.04, p < 0.001. Of the subscales, only the BPNSFS *competence* scale was significant in predicting unique variance in postnatal PSE, β = 0.37, p = 0.006.

At T3, a subset mothers (N = 31) submitted completed the Parental Stress Index (PSI, Abedin, 1995), a measure of parent-child relationship quality. A second relationship-quality measure, the Five Minute Speech Sample (FMSS; Cher-Sensor, 2015) has been completed by 16 mothers. As hypothesized, the BPNSFS is correlated with PSI, r (31) = -0.42, p = 0.02. A linear regression predicting PSI from BPSN is not significant, but using the three BPSN subscales as DVs, with pre- and postnatal depression as controls indicates that support for *relatedness* predicts a significant amount of variance in parent-child relationship quality (PSI), β = -0.37, p = 0.049. Correlations with the FMSS are not significant, but are in the predicted direction.

In sum, support for the basic psychological needs of *autonomy, competence,* and *relatedness* during childbirth predicted parental self-efficacy and better parent-child relationship quality in the postpartum months.

P1-H-199 - Frontotemporal EEG coherence and social behavior in infancy

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Details

Infants are active participants in social environments and early social behavior is predictive of later social deficits, including autism spectrum disorder (Mundy et al., 1990). Connectivity between the prefrontal cortex and temporal areas associated with language and social cognition has been suggested as a potential early biomarker for social cognition (e.g. Broomell & Bell, 2019; Broomell et al. 202; Filley, 2020). Electroencephalogram (EEG) coherence is a non-invasive measure of connectivity between cortical regions. The current study examines how frontotemporal connectivity is associated with social behavior in infancy using both parental report and lab-based task.

We examined 31 infants between the ages of 9 and 12 recruited from rural Appalachia to participate in a lab study. Infants completed the book task from the Early Social Communication Scale (Mundy et al., 2003) and number of instances of initiating joint attention (IJA) and responding to joint attention (RJA) behaviors were coded by trained research assistants. Parents completed the Vineland Adaptive

Behaviors Scale (Sparrow et al., 2016). Higher scores on the Vineland indicate more impairment. Baseline EEG was collected while the infant watched a video of shapes moving and the squared cross correlation of power between electrode pairs F3-T7 and F4-T8 were calculated as frontotemporal coherence.

Frontotemporal EEG from electrode pairs F3T7 and F4T8 during baseline were correlated with responding (r = -.62 *p* = .002; r = -.55 *p* = .006), but not initiating joint attention (r = .11 *p* = .626; r = .09 *p* = .696). Average frontotemporal EEG across both hemispheres predicted RJA, but not IJA, controlling for sex (R^2 = .40, *p* = .006), with average frontotemporal coherence predicting unique variance in the model (beta = -.653, *p* = .002). Examining the components of the socialization domain of the Vineland, frontotemporal coherence predicted the Playing/Leisure time scale (beta = .436, *p* = .029), but not the Interpersonal Relationships or Coping Skills scales.

These findings further illuminate the impact of frontotemporal connectivity on the development of social behavior in infancy and begin to replicate previous work on this association. Poster will discuss implications and future directions.

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P1-H-200 - Do human newborns attend to prosocial interactions?

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Details

Recent developmental models proposed that humans evolved a predisposition to prefer prosocial over antisocial interactions (Dawkins et al., 2020; Hamlin, 2013; Hamlin et al., 2007; Wynn et al. 2018), as suggested by young infants' early preference for agents performing different kinds of prosocial interactions (Geraci & Surian, 2023; Hamlin et al., 2010; Hamlin & Wynn, 2011).
Findings on newborns have shown that they are already sensitive to several features of actions and gestures. In particular, some studies provided evidence for an early sensitivity to the goals of actions directed toward objects (Craighero et al., 2011), as well as towards facial targets (mouth vs. chin) (Addabbo et al., 2022). These findings provide evidence for an early sensitivity to goal-directed action toward objects as well as a social stimulus (e.g., the mouth). To date, no study explored newborns' ability to represent social interactions displayed by two interacting agents.
The present study investigated whether 5-day-old newborns manifest a visual preference for prosocial interactions. We explored newborns' visual preferences for prosocial interactions as compared to antisocial interactions in two different pairs of scenarios: approaching versus avoiding (Experiment 1) and helping versus hindering (Experiment 2). Newborns looked longer at the prosocial interaction in both experiments. To assess whether this preference for prosocial over antisocial interactions was determined by the social nature of those actions, in each experiment a separate group of newborns was presented with videos displaying one agent performing the same physical actions on an inert object. In this non-social condition no reliable preference was found. Finally, a replication study of social condition of Experiment 2 (Experiment 3) confirmed newborns' preferences for helping over hindering actions. Taken together, our results reveal selective attention to prosocial interactions, suggesting an innate predisposition to evaluate social interactions, as well as to prefer prosociality.

P1-I-201 - The impact of paternal odor on emotion processing in 7-month-old infants – EEG measurements

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Details

We, as humans, are a highly social species and rely on a variety of social cues, which we extract from our environment for our everyday interactions. This is not only true for adults but for infants as well. A skill that already develops in infancy is the differentiation between various basic emotional expressions (Peltola et al., 2009; Jessen et al., 2016). By seven months, infants typically show an enhanced attentional response to fearful compared to happy expressions – which is known as the fear-bias (Vaish et al., 2008). In addition, it has been demonstrated that the usual enhanced neural response to fearful faces in 7-month-olds was present when infants were exposed to an unfamiliar mother's odor but absent when they could smell their own mother (Jessen, 2020). These results and other studies (e.g. Durand et al., 2013; Durand et al., 2020) can be interpreted as an evidence for an important role of social odor in various facets of early development. However, this has rarely been studied in humans, in contrast to other species, in particular rodents (Sullivan et al., 2020). It seems like the modality of olfaction plays an important part in communication and daily interactions and therefore should not be ignored as a signaling sense. This present study aims to investigate the impact of paternal odor on face processing (male and female faces) and processing of emotional facial expressions (happy and fearful) in 7-month-old infants.
To do so, we test a group of n=30 7-month-old infants (± 2 weeks) in a within-group design. Infants are invited for two independent EEG appointments within 4 weeks. On one appointment, infants are exposed to their father's odor during the experiment and on the other, infants are exposed to the odor of a different infant's father (stranger's odor). The order of odor presentation is randomized, and during both appointments, infants are presented with pictures of emotional facial expressions (see Figure 1) while we record the EEG signal. Compared to our prior results with maternal odor, we predicted that the father's odor should also lead to a reduced fear response.
Data collection is still in progress, but preliminary analysis from 25 infants suggest an increased Nc to fearful compared to happy faces for both odor conditions, but an overall larger Nc response in the presence of the father's odor (see Figure 2).
Our initial results therefore point to an influence of the father's odor on face processing in infancy.

https://aspredicted.org/CLG_DBM

P1-I-202 - Mind-minded mothers: promoting mind-mindedness in mothers of children with developmental disabilities through a telecare intervention.

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Details

Rationale. Parents of infants with developmental disabilities (DDs) often face more stressors than families with typically developing children, as emotional, cognitive, and socio-interactive dysregulation that in turn can dramatically impact caregiving behavior. Mind-mindedness (MM, i.e., the propensity to view the child as a mental agent with his own thoughts, feelings, and desires) is a relevant parental factor that may

promote positive outcomes for both parents and children, even in the presence of DDs. Video feedback interventions can promote MM by helping parents to become more aware of their child's mental states.

Goal. In this study, we examined the relationship between MM and the mother's parenting stress, the child's temperament, and the quality of the interaction during a free-play task. Moreover, we tested the potential efficacy of a telecare VF intervention in improving maternal MM.

Methods. The present project is part of the ongoing RCT Supporting Parenting at Home – Empowering Rehabilitation through Engagement (SPHERE) project. Mothers assigned to the experimental arm received six weekly TVFI sessions: four sharing the focus sessions, dedicated to joint review video segments and the discussion of specific themes; two integration sessions, during which the mother plays with the infant while the psychologist provides dyadic-tailored guidance based on topics discussed during the previous sessions. For both arms, each assessment session includes (a) an online questionnaire on maternal and infant well-being (parenting stress and infant temperament) and a mother-child dyadic interaction videotaped during a videoconference. Videotaped interactions were micro-analytically coded using the Meins' Mind-mindedness coding manual and an ad hoc coding system.

Results. Preliminary results of the pilot study (n=15) showed that mothers who made more appropriate *mind-related comments* perceived their child as less difficult ($r=-0.71$; $p<0.05$), while no significant associations emerged for other parenting stress dimensions. Considering child temperament, a significant positive association emerged between cognitive mind-related comments and infants' orienting/regulation ($r=0.71$; $p<.05$). MM was also associated to interactive strategies used by the mothers when teaching how to use a new toy: non-attuned comments correlated positively with inefficient parent-lead behaviors ($r= .66$; $p>.05$), while appropriate mind-related comments were significantly associated with efficient action guidance ($r= .61$; $p>.05$). The VF telecare interventions was feasible and appreciated by the mothers and analyses showed a significant increased use of appropriated mind-related comments (Figure 1).

Discussion. MM represents a relevant factor that can influence maternal well-being, interactive strategies, and child development, even in the presence of DDs. VF interventions, also when implemented through a telecare approach, may improve maternal mind-mindedness. By investing in early intervention, we aim to provide families with timely and efficient support in the rehabilitation journey, contributing to growing the caregiver's mentalization.

Figure 1. Comparison of pre-intervention and post-intervention maternal MM

P1-I-203 - The effects of Covid-19 related measures on neural face categorization and emotional face processing in the first four years of life

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Details

Introduction: Facial input is crucial for the development of face processing. However, the measures taken in response to the Covid-19 pandemic likely decreased the variety of facial input. This study

investigated the effects of Covid-19 related measures on two facets of face processing: face categorization (differentiating between faces and houses) and emotional face processing (differentiating between happy, fearful, and neutral facial expressions). **Methods:** Infants (five-month-olds; 10-month-olds) and children (3-year-olds) participated in the YOUth-study. To test the effects of the pandemic-related measures, we compared age-matched groups of children tested *before* (total N = 462) versus *after* (total N = 473) the initiation of these measures. Using Electroencephalography (EEG) we recorded brain activity in response to houses and neutral faces (tested in all children), and to happy and fearful faces (tested in the ten-month-olds and three-year-olds). **Results:** For face categorization, we observed no interaction between stimulus-type and covid-groups (see Table 1 Covid-group x stimulus), indicating that the fundamental process of differentiating faces from non-face objects is resilient despite the reduced variety of input. In contrast, emotional face processing was affected (see Table 1 and Figure 1): children tested before the start of the measures showed differential brain activity in response to all emotional expressions, whereas those tested after showed no differentiation between happy and fearful expressions. This effect was primarily attributed to a reduced amplitude in response to happy faces in the later neural components (P400 and Nc in Figure 1A and 1B respectively). **Discussion:** Arguably, during the Covid-19 related restrictions, young children had reduced experience with happy faces. The current results suggest that such reduced experience might have led to reduced familiarity with, and reduced attention towards happy facial expressions. This large-scale study is the first to reveal that while reduced variety of social input does not hinder face categorization, it negatively affects emotional face processing in both infants and 3-year-olds.

P1-I-204 - Emerging repertoires of regulatory behaviour: Identifying profiles of emotion regulation in early life

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Details

While adult emotion regulation literature has transitioned from its focus on comparing regulatory behaviours to an emphasis on regulatory flexibility, developmental literature continues to measure emotion regulation as a unitary construct or to label behaviours as “adaptive” or “maladaptive.” Bonanno and Burton’s (2013) model of regulatory flexibility posits that successful regulation consists of a diverse repertoire of regulatory strategies, sensitivity to context, and responsiveness to feedback. The current study aimed to explore the emergence of a repertoire of regulatory behaviours in early life by identifying profiles of regulatory behaviour at four time points from infancy to preschool (6 months, 12 months, 18 months, and 4 years). Mother infant dyads (n = 167) underwent the Still-Face procedure (Tronick et al., 1978) at Time 1, and a three-minute interference task (mother completes and attends to a questionnaire while infant plays close by) at Times 2, 3, and 4. In each period, mothers were not emotionally available to their infants, inducing mild distress. Emotion regulation behaviours were observationally coded at each time point (self-comfort regulatory, self-comfort exploratory, attention-seeking, escape, gaze aversion, dyadic exchange, independent play, non-compliance, fretting). Parenting behaviours (maternal sensitivity, maternal non-hostility) were observationally coded using the Emotional Availability scales (3rd ed., Biringen et al., 2000). At Time 4, child temperament (emotionality, sociability) was measured using the Emotionality Activity Sociability Scale (EAS-2; Buss & Plomin, 1986).

For a subset of the sample for which data were available at a fifth time point in middle childhood (9-12 years), we tested the longitudinal association of regulatory profiles at each time point with positive and negative socioemotional outcomes (emotion regulation, social skills, and internalizing and externalizing problems). Distinct profiles of regulation were identified at each time point, and the profile characterized by a varied regulatory approach was used as the comparison group. Positive parenting behaviours were predictive of profile membership at each of the four time points. At Time 4, child sociability was predictive of profile membership. Membership in a regulatory profile characterized by varied regulatory behaviours was predictive of positive socioemotional outcomes in middle childhood at Times 2, 3, and 4. Results from this study suggest that infants demonstrate distinct profiles of regulatory behaviours from a young age, with some infants using a more diverse repertoire of behaviours than others. Both parenting behaviours and temperament played a role in the development of regulatory behaviours. Finally, results from our longitudinal analyses suggest that early repertoires of regulatory behaviours may promote positive socioemotional outcomes in later life. Results from this study add to the literature by challenging current models of emotion regulation development and testing principles of regulatory flexibility in young children.

P1-I-205 - Maternal smartphone use and infants' emotional regulation: Does maternal postnatal distress matter?

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Details

Introduction. Maternal stress, anxiety and depression across the first year of life can significantly impact maternal sensitivity and responsiveness to infants' signals, potentially disrupting the development of infants' emotion regulation. The increase in maternal smartphone use might affect infants' emotional behaviour during early dyadic interactions. More research is needed to understand how maternal smartphone use might affect infant behaviour during early interactions and the possible role of maternal psychological distress. **Aims**. This is part of an ongoing study that aims to investigate the impact of maternal smartphone use on infants' behavioural regulation and the potential influences of maternal psychological distress in this response. **Methods**. Mother-infant dyads (n=10) participated in a modified Still-Face Paradigm when infants were 3-4 months of age. The experiment included five episodes (Figure 1): 1) Free play (2min), 2) Smartphone distracted (*Tecnhoference*; 1min), 3) Reunion (2min), 4) Paper distracted (*Paperference*; 1min), 5) Reunion (2min). In conditions 2 and 4, mothers were required to complete a questionnaire on a smartphone or a printed form while unresponsive to their infants. The order of these two conditions was counterbalanced in the sample. Mothers were asked to complete three self-report questionnaires to assess maternal anxiety, depression, and stress symptoms, namely, the 7-item Generalized Anxiety Disorder (GAD-7) scale, the 10-item Edinburgh Postnatal Depression Scale (EPDS), and the 10-item Perceived Stress Scale (PSS-10). Mother-infant behaviours were continuously recorded using a 360-camera and microanalytically coded through the Noldus Observer software. Positive and negative affect, gaze orienting, self-comforting behaviours, and social bids of infants across the whole procedure were assessed. Repeated-measure analyses of variance (ANOVAs) were performed to investigate infant behaviour changes across the procedure. Pearson correlations were employed to

investigate associations between maternal psychological state and infant behaviour. **Results.** Infants showed a "still-face effect" during maternal smartphone use, as indicated by a decrease in positive affect and increased gaze aversion compared to free play. Noteworthy, some associations between maternal psychological state and infant behaviour were observed: infants of mothers exhibiting higher depressive symptoms displayed, respectively, more positive affect and less negative affect during the free play episode. They also showed greater gaze aversion during the reunion. Furthermore, greater maternal anxiety was associated with more infants' gaze to the maternal face during free play. **Discussion.** Albeit preliminary, current findings suggest that maternal smartphone use is associated with stress-related behaviour in infants and highlights potential directions for future research in the field and implications for educational interventions.

Figure 1. Schematic representation of the experimental procedure and setting.

P1-I-206 - Social support and parity affect the trajectory of maternal bonding during pregnancy

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Details

Study's objective: Research suggests that maternal-fetal bonding (MFB) develops gradually during pregnancy, increasing with advancing gestational age (Tichelman et al., 2019). However, studies examining typical or normative trajectories of MFB in low-risk pregnancy are lacking. In addition, although previous studies identified duration of gestation and other factors (e.g., social support; da Rosa et al., 2021) to be associated with MFB, no previous study examined factors moderating the effects of length of pregnancy on MFB. It is therefore the aim of the current study to examine the longitudinal trajectory of MFB across pregnancy in low-risk women, along with potentially moderating effects of parity, fetal sex, and social support.

Methods: Women were recruited in collaboration with three gynecological clinics during their prenatal medical checks. Healthy women (N=260) with singleton pregnancies took part in this study (M_{age} = 31 years, 63% primiparous). Participants completed the Maternal Antenatal Attachment Scale (MAAS; Condon, 1993) at five time points during pregnancy (mean, SD): 9.2 (±1.5) gestational weeks (gw), 12.2 (±2.1) gw, 16.2 (±2.8) gw, 24.2 (±2.8) gw, and 33.1 (±1.9) gw. At all time points, women also completed the Perceived Social Support Scale (PSSS; Blumenthal et al., 1987; Zimet et al., 1988). To test whether MFB underwent significant changes across pregnancy, we employed linear mixed effects models (LMM), considering individual identity as a random intercept and individual-level trajectory as random slope. Nonlinear temporal trends were fitted by natural cubic splines. To examine the effect of parity, fetal sex and social support on longitudinal trajectories of MFB, we included these variables in the LMM as moderators of the effects of length of pregnancy on MFB. The models were adjusted for maternal age, educational level, marital status, family income, planned pregnancy, miscarriage or abortion in previous pregnancy, and depressive symptoms.

Results: The MAAS global scores, as well as both Quality and Intensity subscales scores, displayed nonlinear changes over time (Figure 1), showing a clear monotonic and asymptotic increase across pregnancy. We observed no significant interaction between length of pregnancy and parity, fetal sex or social support in their effect on MAAS global scores. However, we observed a significant interaction between the length of pregnancy and social support in their effect on the Quality subscale scores, such that women with low social support had lower Quality scores compared to those with mean and high social support scores, a difference that tended to decrease as pregnancy progressed. Moreover, we found a significant interaction between the length of pregnancy and parity in their effect on the Intensity subscale scores, such that primiparae showed higher Intensity scores than multiparae, a difference that tended to grow stronger as pregnancy progressed.

Conclusions: In low-risk pregnant women, MFB undergoes significant nonlinear changes over pregnancy, being lowest at the beginning, and highest at the end of pregnancy. Women with higher social support and those expecting their first child displayed higher MFB scores across pregnancy, with these differences changing across the prenatal period.

P1-I-207 - Naturalistic fussing behaviour in infancy: changes over development and maternal responses

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Details

Fussing and crying play a significant self-regulatory role in infancy and seem to be influenced not only by infant traits (e.g. age) but also by caregiver characteristics, like maternal mood and soothing strategies (Mohr et al., 2019). These self-regulatory behaviours have long-term consequences on children's cognitive development and mental health (Cook et al., 2019). Due to the challenges of studying these behaviours in a laboratory setting, our understanding of how they unfold and evolve over development is currently limited. Questions like what factors within the mother-infant dyad can predict these behaviours and how mothers' behaviour changes to respond to them are still underexplored. This study aims to 1) determine developmental changes in the frequency and duration of naturalistic infant fussing behaviours, 2) describe the maternal behaviours in response to infant distress, and 3) assess how these dynamics change as a function of maternal anxiety and infant number of siblings. Data were collected as part of the ERC-funded Oscillatory Neural and Autonomic Correlates of Social Attunedness project, which tracks infants and their mothers over the first 30 months of life. The sample for this study comprises 48 infants (5-month-olds n=24, 15-month-olds n=24) and their mothers. Free-flowing tabletop interactions were video-recorded during an infant-mother joint play session at 5 and 15 months old. Infant and mother gaze and touching behaviours, as well as episodes of infant fussing (determined by facial gestures and crying), were manually coded on a frame-by-frame basis (50fps). Maternal vocalisations were also processed using a Voice-Type Classifier. To explore maternal responsiveness to infant distress, both infant and maternal time-series behaviours were synchronised, and maternal behaviours were time-locked to episodes of infant distress. To assess maternal anxiety

levels, the GAD-7 questionnaire was applied. Cross-sectional analysis will be performed (https://osf.io/xsjct). Descriptive analysis will identify the frequency and duration of fussing-out episodes and the main maternal responses to infants' distress. T-test analyses will determine differences between the two age groups. Logistic regression analyses will test if maternal anxiety and the number of siblings influence the probability of fussing out. Finally, we will use linear regression analyses to assess if maternal anxiety level, infant age, and number of siblings predict the frequency and duration of fussing-out episodes and the maternal behavioural responses. We expect fussing behaviours to decrease in frequency and duration over development as infants get better at self-regulation. Maternal anxiety may be associated with more frequent and longer episodes of infant fussing out and with more intrusive behaviours (i.e. number of vocalisations, looks towards baby and touch). Finally, we anticipate the number of siblings predicting the frequency and duration of fussing behaviour, as those growing up with more siblings may have to compete for their caregivers' attention, resorting to crying and fussing out as a common strategy. Studying self-regulatory behaviours such as fussing and crying in infancy, alongside maternal anxiety, is essential for uncovering associations between maternal behaviours and the frequency/duration of infant distress. Such insights can contribute to targeting specific factors that require intervention in early regulatory problems.

P1-I-208 - Comparisons and interrelations of real-time emotions in father-mother dyads

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Details

Despite growing understanding of fathering and father-child interactions over the last few decades, little is known about men's emotional experiences in the fathering role (Palkovitz & Hull, 2018), including distinctions from or interconnectedness with mothers' emotions. Understanding parents' emotional experiences is important given associations with mental and physical health, parenting and caregiving behaviors, and overall family well-being (e.g., Brown & Cox, 2019; Huppert, 2009; Kerr et al., 2021). This study used ecological momentary assessment (EMA) to assess and contrast the relationship between fathers' and mothers' real-time emotions across moments when they were caring for their children compared to when they were not.

The sample included 44 father-mother dyads of preschool-aged children (35-52 months). Parents were primarily married or partnered (93%), 50% white, 50% college educated, with a median income of $60-$80,000. Over 10 days of EMA (5 surveys per day), parents reported current positive and negative emotions and whether or not they were with their child (*with child*). Dyad members received each survey at the same time.

We conducted separate dyadic multilevel models for positive and negative emotions, specifying a random slope of *with child*. Within-person effects indicated that fathers, but not mothers, reported

lower negative emotion when they were caring for their children compared to when they were not. Between-person effects indicated that mothers, but not fathers, who spent more time with their children during the study reported higher overall positive emotion. Further, both fathers and mothers who spent more time with their children during the study reported lower negative emotion compared to parents who spent less time with their children (see Table 1).

For both positive and negative emotion, dyadic random effects indicated that fathers' and mothers' intercepts were correlated, suggesting that dyads reported similar overall levels of emotion. For negative emotion only, there was a negative correlation between fathers' and mothers' *with child* slopes. In other words, fathers who reported a greater difference (steeper slope) in negative emotion when with their children compared to when they were not , were paired with mothers who had weaker slopes (less difference) of negative emotion across caregiving contexts. Finally, interpersonal intercept-slope covariances revealed that fathers' slopes were negatively correlated with mothers' intercepts, while mothers' slopes were positively correlated with fathers' emotion intercepts. In other words, the degree to which fathers and mothers reported differences in negative emotion based on being with their child depended on their coparents' average negative emotion (see Table 2).

Taken together, results revealed that fathers and mothers of preschool-aged children report distinct yet interrelated emotional experiences during parenting. Parents' overall reports of emotion were positively associated, but dyadic partners did not experience time with their children in the same ways. These findings advance understanding of parents' lived experiences in context, and highlight the importance of continuing work that explores fatherhood as a distinct and valuable emotional experience. Understanding contexts in which fathers report higher or lower positive and negative emotion may inform avenues for intervention that can enhance fathers' mental health and well-being.

P1-I-209 - Predicting toddler self-comforting from parenting behaviors and dyadic interaction

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Details

Toddlerhood is a crucial developmental stage where children transition from basic emotional expression to more complex regulatory skills (Cole et al., 2004). Self-comforting is a strategy that young children use to help modulate their emotions, and parenting behaviors, specifically intrusiveness and directiveness, may play a crucial role in shaping child emotion regulation. Children exposed to intrusive and/or directive parenting often struggle with effective emotion regulation (Morris et al., 2007). Mother-toddler reciprocal exchanges play a pivotal role in shaping infant emerging socioemotional competence (Feldman, 2015); however, true mother-child dyadic interaction (reciprocity and conflict) is not typically examined. The current study explores the complexities of child self-regulation by examining the

interplay of individual parenting behaviors (intrusiveness, directiveness) and dyadic interaction (reciprocity, conflict) in predicting child self-comforting during toddlerhood. We examined dyadic interaction as moderators of the associations of parenting behavior to child self-comforting.

Mothers (*n*=140) and toddlers (*M*=32.10 months, *SD*=1.63 months) were observed to measure study variables. Maternal intrusiveness and directiveness were observed on a 4-point scale in a 4-minute free play task where dyads were asked to play with a town toy as they would at home. Intrusiveness included manipulating, over-directing, and over-controlling behaviors. Directiveness included adult-centered, strict, harsh, or demanding behaviors. Dyadic interaction was observed in a 3-minute teaching task, where mothers taught children how to solve a puzzle. Reciprocity included shared positive affect, eye contact, and turn-taking, and conflict included disagreement, shared negative affect, and tussling over toys. Child self-comforting behaviors were measured in two-minute emotion-eliciting tasks. Experimenters played with a puppet to elicit pleasure, and a jumping toy spider was introduced to children as a novel task. Self-comforting, engaging in any manipulation of body, clothing, or objects, was coded in 5-second intervals as presence/absence.

Given the significant relations among maternal education, child fear, and sadness, they were controlled for. In the first model, reciprocity moderated the relation of maternal intrusiveness to child self-comfort (Figure 1). When reciprocity was high, more self-comforting was associated with high intrusiveness, but not when reciprocity was low or moderate. In the second model, conflict moderated the association of maternal directiveness to child self-comforting (Figure 2). When conflict was high, but not when conflict was moderate or how, less directiveness was associated with more self-comforting.

Findings indicate complex relations among these constructs, which were examined in different contexts. Differences were found when examining parenting behavior versus dyadic behavior during mother-child interactions. Dyadic interaction may be just as important to consider as individual parenting behaviors when considering the development of children's regulation. Mothers may implement more responsive and attentive parenting practices to enhance reciprocity with their toddlers as a protective factor and practice less directive parenting to allow their toddlers to use internal sources of regulation skills rather than relying on external sources, such as maternal instructions, when conflict situations arise. Thus, parents can provide an atmosphere that allows their toddlers to practice their autonomy, which leads them to learn self-regulation skills; these skills might become fundamental sources of optimal emotion regulation in the future.

P1-I-210 - Infants' attentional and affective responses to eye contact with a human and with a humanoid robot: A psychophysiological study

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Details

Eye contact is a fundamental component of social interaction across the lifespan. Psychophysiological research has shown that eye contact elicits attentive and affective responses in observers. Moreover, as

humanoid robots have significantly advanced in their capacity to imitate social interaction, people now respond attentively and affectively to eye contact not only with a human but also with a humanoid robot. This suggests that humanoid robots are perceived as social agents. However, because previous studies have primarily investigated these responses in adults, the development of attentional and affective responses to eye contact remains unclear.

The present study addressed two critical questions: First, do infants already experience attentional and affective responses to eye contact with another human? Second, do the infants' attentive and affective responses extend to eye contact with a humanoid robot? In this study, 114 infants (6–8 months old) observed direct (toward the infant) and averted gaze directions of a human and a humanoid robot, while their heart rate deceleration (measured with electrocardiography, indexing attention orienting), skin conductance (indexing affective arousal), and facial muscle activity (measured with electromyography from zygomaticus/cheek and corrugator/eye brow areas, indexing affective or affiliative responses) were measured.

The results showed that infants' heart rate deceleration was sensitive to gaze direction. However, heart rate deceleration was stronger in response to averted gaze compared to direct gaze, suggesting that infants allocated more attention toward a person looking away from them. A possible explanation for this result is that occurrences of averted gaze are important for the development of joint attention skills. Interestingly, infants' heart rate deceleration was also greater in response to averted versus direct gaze of a humanoid robot, suggesting that infants recognize social significance in robotic gaze and perhaps expect robotic gaze to provide information about the surrounding environment. Regarding affective arousal, infants' skin conductance was not sensitive to the gaze direction of a human or a humanoid robot. However, infants' facial muscle activity differentiated between the direct and averted gaze of a human and of a humanoid robot. Specifically, zygomaticus activity shifted more in the positive direction (indexing muscle contraction) in response to direct gaze compared to averted gaze. In line, corrugator activity shifted more in the negative direction (indexing muscle relaxation) in response to direct versus averted gaze. It remains an open question whether these facial muscle responses to eye contact reflect infants' experienced positive affect or displayed affiliative and communicative signals toward the other. Overall, the results suggest that infants perceive humanoid robots as potential social interaction partners.

P1-I-211 - Infant processing of the mother's face and longitudinal associations with emotional reactivity in the first year of life

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Details

Past research has focused on infant abilities to discriminate and process the mother's face, however it is still unclear how visual and brain responses to this socially relevant stimulus converge, change over time and what individual factors associate with such changes.

A longitudinal study (N ~ 60) was conducted to investigate the trajectories of infant visual preference and brain responses (ERPs) to the mother's face (vs a stranger's face) and how these are related to the development of emotional reactivity in the first year of life. Infants took part in the study at 2 weeks, 4 months, 6 months and 9 months of age. At each time point, mothers were asked to complete a measure of infant temperament via standardised questionnaires.

We found converging evidence of infant visual and brain responses evoked by the mother's face so that these were related to infant falling reactivity, i.e. the ability to recover from distress, in the first year of life. With the behavioural task, we found that while at 2 weeks, 4 months and 9 months of age infants looked equally at both the mother and the stranger faces, infants at 6 months looked significantly longer at their mother's face. In addition, those infants who looked longer at the mother's face at 6 months showed higher falling reactivity at 9 months. Our ERP task revealed that the face-sensitive components were larger to the mother face than the stranger face at 4 months (N290) and at 6 months (P400), however they no longer showed a significant difference between the two faces at 9 months. At this latter age, however, we found that the P400 and the Nc amplitude evoked by the mother's face were associated with infant falling reactivity starting from 4 months of age.

Overall, we conclude that the behavioural responses and the neural processes associated with the elaboration of faces, and specifically the face of the mother, are related to early infant individual characteristics. In this talk, I will discuss these findings in light of the roles that both infant development and the interaction with the caregiver play in emerging emotion regulation capacities during the first year of life.

P1-I-212 - Neighborhood deprivation: how environmental factors shape infant emotional regulation through maternal dysregulation

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Details

Social disorganization theory suggests that neighborhoods with higher levels of disadvantageous conditions impede the development of formal and informal networks needed to solve household problems (Cho, 2022; Shaw & McKay, 1943). As a result, higher levels of neighborhood disadvantage are associated with greater maternal depression and familial disfunction (Kohen et al., 2008), and pose a risk factor for higher internalizing symptoms in children (Raver et al., 2016). Furthermore, parental anxiety is predictive of autonomic arousal and can create a greater disposition for the development of anxiety disorders in children (De Vente et al., 2020). Variation in maternal mood may be indicative of the predictability of neighborhood environmental signals in children's lives, thus impacting their ability to regulate their own emotions (Howland et al., 2006).However, we have little information regarding how neighborhood characteristics impact maternal functioning and regulation to, in turn, shape

socioemotional patterns beginning in infancy. The current pre-registered proposal (https://osf.io/2e3j4) will examine how neighborhood disadvantage relates to maternal internalizing symptoms and subsequently influence their infant's emotional regulation in the second year of life.

Data were collected as part of a larger longitudinal study and include 334 mother-infant dyads. The neighborhood deprivation index was assessed via a composite score of neighborhood block group factors assessed with the American Community Survey 2019 (e.g., average neighborhood income, percentage of residents below the poverty line, etc.) at four months of age (Witherspoon et al., 2016). Respiratory sinus arrythmia (RSA) has been considered a proxy for the capacity to regulate emotion, such that higher RSA is associated with lower risk for internalizing/externalizing symptoms later in childhood (Conradt et al., 2014). Resting RSA was assessed at 18 months, while infants sat quietly on their mother's lap. Finally, maternal self-report of internalizing symptoms was assessed at four timepoints (4, 8, 12, and 18 months) using a latent composite of self-reported symptoms on the Beck Anxiety Inventory (BAI) and Beck Depression Inventory (BDI) at each timepoint.

We will utilize mediation analyses within a modified latent trait-state model to assess if the level of community deprivation has an impact on infant emotional regulation capacity at 18 months via maternal internalizing symptoms (see Figure 1). Within this model, trait-like maternal internalizing symptoms can be conceptualized as a latent average in symptoms across the four time points. State-like fluctuations from that latent average are captured by the latent state variables which include autoregressive paths to capture trend-like carryover effects in internalizing symptoms between timepoints. Regression paths allow us to tease apart how neighborhood disadvantage affects state fluctuations in maternal internalizing above and beyond trait-like components to predict change in infant RSA at 18 months.

In particular, we hypothesized that higher levels of neighborhood deprivation in early infancy will relate to lower infant regulatory capacity in toddlerhood, as indicated by lower RSA at rest. In addition, trait-like elevated maternal internalizing symptoms across infancy (4 to 18 months) will mediate the neighborhood to RSA relation. Finally, greater fluctuation or more instability over time will also mediate.

P1-J-213 - Caregivers' prenatal representations of their child may be negatively influenced by prenatal care experiences

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Details

Background: Caregivers' mental representations, or internal working models of their children, have clinically relevant implications for the parent–child relationship given their link to caregiving behaviors (Guyon-Harris et al., 2022) and attachment security (Benoit, et al., 1997; Zeanah et al., 1994). There is evidence that these representations emerge during pregnancy and remain relatively stable across infancy (Benoit, et al., 1997). Given the importance of caregivers' mental representations of their child, the current study explored one factor that may contribute to initial formations of caregivers' internal working models of the child, namely, prenatal care visit experiences. **Methods:** Participants were 298 pregnant people (Mage = 30.83, SD = 5.00), in mid-gestation (range gestational age 11-38 weeks; M = 23.49, SD = 5.70); 73% identified as White, and all were recruited from the Nashville, Tennessee metropolitan area. Participants were administered a modified version of the Prenatal Working Model of

the Child Interview (WMCI; Zeanah et al., 1996), a semi-structured interview that includes items in which the participant is asked to describe their child's personality (and if possible, provide 5 words or phrases to describe their child now). Those words and phrases were assigned ratings by experts in infant and early childhood mental health, and categorized into positive (e.g., loving; smart), neutral (e.g., active; extraverted), and negative (e.g., stubborn; clumsy) descriptions. Subsequently, at a follow-up visit when infants were age 6 months, a subset (n = 88) reported how much the descriptions that came from prenatal care visits described their child from 1 (*not at all*) to 10 (*very much*). **Results:** We found that the vast majority of the 1500 words/phrases used to describe the unborn child were positive (78.5%), with the remainder roughly split between neutral (11%) and negative (10.5%). Among the total words, one-sixth (16.7%) were reported to be influenced by experiences during prenatal care visits. This subset of 251 words were much less likely to be positive (OR = 0.28 [0.02, 0.37], Z = 8.72, $p < .001$) and much more likely to be negative (OR = 4.21 [2.95, 5.99], Z = 7.97, $p < .001$) than those words not coming from prenatal care visits. At a longitudinal follow-up, when infants were age 6 months, caregivers reported that, on average, the words that were derived from prenatal care visits remained largely accurate in describing their child (M = 7.17, SD = 2.75). **Discussion:** These findings provide evidence that prenatal health care visits are relevant to the internal working models of the child that pregnant people form. We also provide striking evidence that caregiver ideas formed about the child's personality from the visits are much more likely to be negative than ideas from other sources. Given that the perceptions of the child appear to be long-lasting (i.e., at 6 months post birth), these findings suggest the potential role of health care providers' (e.g., obstetricians, ultrasound technicians) interactions with pregnant people as a target for future interventions to promote positive caregiver–child relationships.

P1-J-214 - Gut microbiome alpha diversity and metabolic pathways are associated with social contact in infants

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Details

The hygiene hypothesis suggests that reduced exposure to environmental microbes can lead to various health consequences, highlighting the importance of microbial transmission in early life (Strachan, 1989; Rook et al., 2013). This hypothesis indicates that early childhood exposure to specific microorganisms is crucial for proper development of many physiological systems, such as the brain (Laue et al., 2022). However, the potential role of social contact and hygiene practices in early microbe exposure remains under-investigated. This study aimed to investigate how quantity of social contacts and hygiene practices in early life influence the infant microbiome.

Stool samples were collected at 3 months of age for metagenomic shotgun sequencing (n=311) and metabolomic analysis by LC-MS (n=878) from the Canadian Pregnancy During the COVID-19 pandemic cohort. Quantity of social contacts and hygiene practices was determined by questionnaire and scores were created for each infant. Linear regression models were constructed to understand the relationship between gut microbial diversity and the social contact and hygiene scores. An initial model adjusted only for the scores and a comprehensive model accounted for covariates known to be important to the gut

microbiota. The infant metabolomic data was analyzed using MetaboAnalyst to understand the relationship between metabolic pathways and the social contact and hygiene scores.

The basic model revealed a positive association between Chao1, an estimate of species richness, and social contact (β=1.884, p=0.026, Adjusted R^2=0.013). When adjusting for covariates, the association remained significant (β=2.392, p=0.004) with an improved model fit (Adjusted R^2=0.134). No associations were found with scores for hygiene practices.

Further analysis using MetaboAnalyst revealed significant metabolic pathways associated with these scores. Pathways such as Alanine, aspartate, and glutamate metabolism (p = 3.46e-07, Impact = 0.474); Arginine biosynthesis (p = 1.41e-06, Impact = 0.365); Taurine and hypotaurine metabolism (p = 3.99e-04, Impact = 0.714), and others were significantly associated with the social contact score (Table 1). Pathways associated with the hygiene score included Butanoate metabolism (p = 0.001, Impact = 0.111) and beta-Alanine metabolism (p = 0.001, Impact = 0.160) (Table 2).

Our findings indicate a positive association between social contact and microbial species richness in the infant microbiome. This could be attributed to infants with more social interactions receiving a greater microbial transfer from various individuals. Significant associations were also seen between social contact, hygiene practices, and several key metabolic pathways. These results imply that social and hygiene factors play a role in shaping infant metabolic processes, warranting further research into their implications for infant health and development.

P1-J-215 - Associations with infant birthweight and trust in US physicians during pregnancy

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Details

Infant birthweight continues to be a key indicator of infant health and future development (WHO, 2023). A promising alternative to using individual interventions to improve disparate outcomes is instead focusing on the patient-provider relationship within the prenatal care system (Altman et al., 2020). The connection between trust in one's physician and patient adherence and satisfaction with care has been long documented (Thom et al., 2002), but the current study addresses a gap in knowledge between trust in one's physician during pregnancy and infant birthweight. Given the inequitable experiences birthing people report in healthcare settings (Attanasio & Kozhimannil, 2015; Ward et al., 2013), this study also explores the associations of various sociodemographic characteristics on predicting physician trust during pregnancy.

Data were analyzed from a longitudinal, multi-site study in North Carolina focused on the experiences of pregnant people throughout prenatal care and into the postpartum period. Current analyses reflect participant responses (*N* = 166) during pregnancy (~14 weeks) and at birth (*n* = 71). Structural equation modeling was employed with full information maximum likelihood to account for missing data. The path analysis model examined the association between participant scores on the Trust in Physicians Scale (TiPS; Anderson & Dedrick, 1990) during pregnancy and their infant's birthweight at delivery. Seven

sociodemographic variables of the participant were controlled for: age, income, parity, race, education, employment, and insurance. As data collection for this project is ongoing, the model will be reanalyzed in several months to account for a larger sample.

Descriptive analyses were run prior to the full SEM (see Table 1). Model fit was excellent according to chi-squared (χ^2 [df, 7] = 3.25, p = .861) and component model fit (1.00) values. Results indicated a trending statistical significance between total TiPS scores during pregnancy and infant birthweight (β = 0.22, SE = 0.12, p = .058) controlling for the sociodemographic variables (see Figure 1). Income (β = -0.24, SE = 0.09, p = .007) and parity (β = -0.16, SE = 0.08, p = .042) significantly predicted TiPS scores. The negative associations here indicate that those with higher income and first-time parents, respectively, reported lower trust in their prenatal care physician. Conversely, those who were employed full-time (β = 0.20, SE = 0.08, p = .017) reported higher trust than their counterparts. Age (β = -0.13, SE = 0.08, p = .087) and insurance (β = 0.16, SE = 0.09, p = .061) were trending significant. Race and education were not related to TiPS scores.

These findings highlight an important consideration during prenatal care – the physician-patient relationship is seemingly linked to infant health outcomes. Beyond the sociodemographic characteristics of the parent, the degree of trust one has in their prenatal care physician during pregnancy may relate to their infant's birthweight at delivery. This could have profound implications for the prenatal care system and the training of physicians in relation to their interactions with pregnant patients, especially considering the significant predictive effects of most of the sociodemographic variables on trust in their physicians.

P1-J-216 - Perinatal mental health in GBTQ+ perinatal parents: A rapid review

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Details

Introduction: Perinatal mental health is a significant predictor of parenting quality and child outcomes. Research, policy, and interventions on perinatal mental health have largely focused on heterosexual biological mothers. The relatively limited focus on fathers from gender and sexual minorities leaves the growing population of fathers from these minority groups, and their children underrepresented in the evidence base for perinatal parent mental health, parenting, and parent-infant interaction. The current systematic rapid review examines the research on perinatal mental health in fathers from gender and sexual minority groups. The aim of this rapid review was to inform evidence-based provision on perinatal mental health for gender and sexual minority fathers and their children. Methods: The rapid review was run across PubMed and PsychInfo databases with 750 studies resulting from the search. Following title, abstract, and full-text screening using Covidence software, 30 studies were evaluated with MMAT appraisal tool before narrative synthesis. Results: Across the 30 studies on gender and sexual minority perinatal paternal mental health the following patterns of research were observed: Fathers in gender and sexual minorities were less likely to receive appropriate and relevant support following pregnancy loss from health settings, as well as in the workplace. Fear of childbirth (FoC) may be a debilitating mental health concern and may be increased in rate following previous pregnancy loss.

Fathers from gender minorities are more likely to experience FoC linked to fear of stigma in the healthcare setting during pregnancy and birth. Gay fathers by surrogacy are a planned parenting group, showing increased mental health resilience in the postpartum period and transparency in discussing their path to parenting, in comparison to heterosexual parents by assisted reproduction technologies (ART). Biological relatedness does not appear to link to perinatal mental health in gay fathers, or the caregiving role of fathers post-birth. For expectant gay dads by surrogacy who do struggle with mental health anxiety may be more prominent antenatally and depression postnatally. Failed infant adoption is often not recognized as a form of loss to gay expectant parents, but can be associated with grief, feelings of loss, and challenges to mental health and wellbeing. Gay fathers report the feeling of this loss being minimized and marginalized. National Mental Health Review (NHS England, 2016) in England and the NHS Long Term Plan (NHS, 2019) both fall short of being inclusive of fathers from gender and sexual minority groups. For fathers from gender minorities, unplanned pregnancies can occur while on gender-affirming care, and may result in increased concern for mental health. Gender minority fathers may also experience increased gender dysphoria during the perinatal period, as well as these fathers reporting increased minority stress from stigma and lack of information and understanding in the health system. Discussion: Gender and sexual minority fathers may face specific challenges during the perinatal period, and may face additional barriers to accessing information, evidence-based provision, and support for their wellbeing, their parenting, and their children. Delivering evidence-based resources and information for this perinatal population and the health care providers that support them will be key in addressing the gap in current need and provision.

P1-J-217 - Why disparities in adverse delivery outcomes for Black birthing people matter for the birthing person-infant dyad

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Details

Systemic racism within U.S. healthcare has resulted in Black birthing people disproportionately experiencing adverse birth outcomes (House et al., 2020; Njoku et al., 2023). Consequently, Black birthing people may be especially prone to the long-term impacts that delivery complications have on birthing person and infant well-being (Lobel & DeLuca, 2007). Delivery complications have been associated with birthing people viewing their infants less favorably, which disrupts the transactional relationship between them and their infants (Hoffenkamp et al., 2015). Furthermore, unplanned C-sections have been linked to birthing people providing less tactile stimulation and play with their infants (Rowe-Murray & Fisher, 2001) and decreased breastfeeding initiation (Shawky & Abalkhail, 2003). Despite this evidence, limited research examines demographics and their intersectionality as predictors of delivery outcomes. Thus, the current study aims to inform directions for addressing health inequities for Black birthing people and their infants by examining how race and age directly and indirectly predict delivery outcomes.

A retrospective cohort study was conducted using de-identified medical records from a multisite obstetrics practice in the southeastern U.S. (*N*=4,512). Participant age ranged from 15 to 57 (*M*=31.03, *SD*=5.00), with 84% identifying as White. Majority of the sample was partnered (76%) and on private

insurance (91%). We conducted binary logistic regression analyses with race (0=White, 1=Black), age, and their interaction term as predictors of modes of delivery (0=Vaginal delivery, 1=C-section) and labor and delivery complications (e.g., preeclampsia, infant breeched, cord around neck, etc.) as outcomes.

Mode of delivery ($\chi^2(2)=88.26$, $p<.001$) and presence of a complication ($\chi^2(2)=22.80$, $p<.001$) yielded significant models. Birthing age and race both had significant direct effects (see Figures 1 and 2 for results). The odds of undergoing a C-section was 1.06 times more likely for older birthing people and 1.47 times more likely for Black birthing people. Finally, the odds of experiencing delivery complications was 1.03 times more likely for older birthing people and 1.28 times more likely for Black birthing people. The interaction terms in both models were not significant.

Our results demonstrate that Black and older birthing people are at an increased risk of experiencing unfavorable delivery outcomes, even within a population that is predominantly insured and partnered. The non-significant interactions and low model variances indicate that Black and older birthing people are demographic groups that may be uniquely impacted by systemic inequities in healthcare settings and that there are additional underlying factors driving these disparities. While these disparities are considered a public health concern (Hoyert, 2021), we argue that they should also be brought to the forefront of the child development field since disparities in birth experiences may help to explain differences in early parenting stress. More investigation into the mechanisms through which delivery outcomes and the different types of complications influence early parenting behavior is sorely needed. Investigating factors contributing to these disparities will benefit postpartum health outcomes, and therefore, promote positive early birthing person-infant dyadic interactions.

P1-J-218 - Effects of omega-3 supplementation on maternal and infant stress in Black American families

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Details

Background. A primary cause of disparities in maternal and child health between Black and White Americans begins with high exposure to psychosocial stress during pregnancy. Growing evidence indicates that omega-3 fatty acid supplementation reduces maternal stress reactivity during pregnancy and protects infant neurodevelopment, particularly in high-stress contexts. The Nutrition and Pregnancy Studies (NAPS) focus on nutrition as a moderator of prenatal stress regulation in Black women exposed to high levels of unpredictable stressors, resource related stressors, and discrimination stress with the potential to improve birth and neurodevelopmental outcomes. We previously reported that compared to the placebo group, women who were assigned to omega-3 fatty acid supplementation, specifically docosahexaenoic acid (DHA), during pregnancy reported lower reports of perceived stress and had infants who demonstrated a more modulated stress response in a pilot study of 64 Black women and their infants. In the present study we aimed to replicate and expand upon those findings in a larger sample using more rigorous measures.

Methods. Data were from a randomized controlled trial of prenatal DHA supplementation in Black women living in under-resourced, urban environments who were healthy, insured through Medicaid,

and were eating less than 2 servings of sea fish per week. Women were enrolled at 10-14 weeks of gestation and randomly assigned to active supplement (450 mg DHA; n= 112) or placebo (n=56) in a 2:1 ratio. Participants and research staff were blind to study assignment. DHA levels were measured via venous blood samples and maternal reports of negative life events and perceived stress were measured at multiple time points during pregnancy. At 4 months post-partum, infants were brought to the laboratory and salivary cortisol levels were measured upon arrival and in response to the Face to Face Still Face (FFSF) paradigm.

Results. Regarding maternal stress regulation, blood levels of DHA at 32 weeks of gestation were negatively associated with perceived stress controlling for exposure to negative life events [F (2, 109) = 18.36, p <. 001]. For infants, cortisol levels upon arrival to the laboratory were lower for infants of mothers whose blood levels of DHA increased from baseline to 32 weeks of gestation, controlling for time of day of sampling and maternal exposure to negative life events [F (4, 82) = 3.57, p < .05]. Level of increase in cortisol in response to the FFSF paradigm was not associated with maternal DHA levels.

Conclusions. We replicated our previous finding of the impact of omega-3 supplementation during pregnancy on stress regulation in Black women and expanded the results to demonstrate that increasing the level of DHA during pregnancy is associated with infant stress systems. DHA supplementation is a promising approach to supporting healthy pregnancies in Black women living in low-resourced environments. Incorporating DHA supplementation as part of the standard of care may reduce racial disparities in perinatal health. It will be important to examine if the present results are generalized to other populations who experience disparities in health as a function of race, ethnicity, and or poverty.

P1-J-219 - Creation of the GSED Long Form for directly assessing children 0-3 years globally

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Details

Introduction: Directly administered tools for assessing children 0-3 years that are valid, reliable, and comparable globally are lacking. Most available tools were created in Western countries and are expensive, proprietary, time intensive to administer, available only to highly trained professionals, and consist of items that may be irrelevant or require significant adaptation to low resource settings. We aimed to develop an open-access direct administration tool that overcomes these limitations, and is affordable and reliable across geographies, cultures, and languages without necessitating major adjustments (besides translation) to the local context. We aimed for the tool to be administrable with a tablet-based application (App) to simplify assessments and improve data quality.

Methods: Assessment data for 66,075 children (100,153 observations) from 51 cohorts in 32 countries utilizing 18 existing developmental tools were analysed using a modified Rasch model. 807 items were identified that demonstrated similar psychometric properties across countries and tools. These items

were reviewed for conceptual overlap, developmental domain coverage, applicability across contexts, and feasibility of item administration. Two subject matter experts independently created, then through consensus, agreed on a shortened list. Feasibility, age-related spread of item difficulties from the Rasch model and coverage of developmental domains were also reviewed. A final set of 155 items was chosen, instructions written, training materials developed, and a test kit of low-cost materials specified. An innovative App was created for data collection with automated start, go back, and stop rules and user-friendly information icons. Items were organized into three streams (not domains) based on: similar behaviours that manifest in succession (e.g. walking and running; building towers of blocks of various heights; identifying and naming pictures); and types of test kit materials. Items were arranged in a grid pattern by stream so that they could be viewed simultaneously and incidental observations scored in any order, thus facilitating assessment flow and helping maintain children's interest. The resulting Global Scales for Early Development (GSED) Long Form (LF) was rigorously translated and back-translated, piloted, and revised iteratively in three countries (Bangladesh, Pakistan, and United Republic of Tanzania) before being validated.

Results: Validation results of the GSED LF scores are presented separately in this symposium (paper 2). Here, we show the results of the test and item functioning in the three countries and present feedback from field assessors of what worked or not. Item difficulties were reviewed for order of administration and items with poor fit to the Rasch model were reviewed in a consensus meeting regarding feasibility, translation and training issues. 18/155 items moved position and 13/155 items required minor changes to wording and/or additional instructions to support training. Assessors favourably reviewed the overall design of the tool and the App.

Conclusion: Compared to Western-based proprietary directly administered assessment tools for children 0-3 years, the GSED LF is affordable and feasible across diverse global settings without major adaptations other than translation. Data quality, assessor training and reliability of assessors may be supported by the use of a tablet-based App that aids in test administration and data collection.

Poster Session 02

P2-A-220 - Navigating objects in the path in free-roaming crawling and walking infants and their caregivers

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Details

Locomotion requires more than moving the limbs. Functional locomotion requires coordination between perception and action to navigate everyday environments, where toys, shoes, and household objects are strewn about. Do infants (and their caregivers) plan their steps to avoid stepping on or bumping into objects on the floor?

Using a within-subjects, age-matched design, we tested 24 crawling and 24 walking infants (*M* = 12.5 months) during free play with their caregivers. Dyads played in two 10-minute conditions in which we varied the density of obstacles on the floor—26 small toys clustered in one location versus dispersed

around the room. We counted each step when the participant's foot (for walking), knee (for crawling), or buttocks (for bum shuffling) contacted an object.

Every infant contacted at least one object (*M* = 16 contacts, range = 1 – 44) during the 20 minutes of play (Figure 1A-B). More object contacts (75%) occurred during swing (while the limb moved through the air; Figure 2A) than landing (upon contacting the ground; Figure 2B). Walkers contacted more objects (*M* = 23) than crawlers (*M* = 10) overall, $t(43.1) = -4.59$, $p < .001$. But walkers also took more steps than crawlers. After normalizing contacts by total step number, crawlers (*M* = 3.9% of steps) had marginally more object contacts than walkers (*M* = 2.8% of steps), $t(34.36) = 1.78$, $p = .08$. Infants were within six inches of a toy on *M* = 62% of locomotor bouts when toys were clustered, and *M* = 48% when toys were dispersed. Consequently, infants had more object contacts when toys were clustered (*M* = 8.6% of steps) than dispersed (*M* = 2.4% of steps), $t(46) = 3.85$, $p < .001$. Object contacts were unrelated to locomotor experience, $r(46) = -.06$, $p = .66$. Moreover, negative consequences were rare: Across all 784 object contacts by infants, only 13 resulted in recovery steps that prevented falling and only 16 resulted in falls.

In contrast to infants, many caregivers (*n* = 29) never contacted an object during free play (*M* = 0.88, range: 0 – 6; Figure 1C-D). Like infants, more obstacle contacts (79%) occurred during swing than landing. Normalized by total step number, caregivers contacted objects on *M* = 1% of steps. Caregivers were within six inches of a toy on *M* = 32% of locomotor bouts when toys were clustered and *M* = 25% of bouts when toys were dispersed, indicating caregivers gave toys a wider berth than infants. Regardless, like infants, caregivers contacted objects more often when toys were clustered (*M* = 2.7% of steps) compared to dispersed (*M* = 0.3% of steps), $t(44) = 2.67$, $p = .01$. Across all 41 obstacle contacts by caregivers, none resulted in recovery steps or falls.

Infants appear indifferent to stepping on or bumping into objects, whereas caregivers are more adept at avoiding objects. An ongoing follow-up experiment is testing whether infants and their caregivers can modify their walking steps to avoid obstacles in their path if necessary to avoid loss of balance.

P2-A-221 - Trade-offs between learning to walk and learning to talk: A new perspective on developmental cascades

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Details

Learning to walk creates opportunities for action and interaction, resulting in advances in communication and language. As a result, the onset of walking has been described as a turning point in language development—a time when, on average, growth in word production increases dramatically. However, there is variability in the rates at which infants' vocabularies grow, and the underlying contributors to this variation are unknown. One possibility is that walking introduces a multitasking problem that infants may differentially navigate. Walking may require more attention to staying upright, thereby reducing available cognitive resources for language development (e.g., Berger et al., 2017). Thus, infants who show more rapid vocabulary growth earlier may do so at a cost to their walking

abilities. We explored this hypothesis by examining two common language milestones—the acquisition of 10 and 50 words—anchored to the onset of walking and asked whether infant walking kinematics differed among earlier and later achievers of these milestones.

We obtained data on infant walking and language from 22 infant-caregiver dyads (17 boys, 5 girls). Walking kinematics (i.e., step length, step width, speed) were assessed during a straight-path walking task using a portable, pressure-sensitive walkway (Zeno Walkway, ProtoKinetics) when infants were 15 months old. Data were processed using field-standard methods. Word production was assessed using the MacArthur Bates Communicative Development Inventory (MCDI) when infants were between 8 and 30 months of age. We identified the ages at which each infant produced 10 and 50 words and normalized these ages to the age at walk onset (i.e., age at language milestone minus age at walk onset). Infants were then classified as *earlier* achievers if they reached the target number of words prior to the group median age or as *later* achievers if they did not. Independent t-tests were used to explore differences in walking kinematics between the two groups for the 10- and 50-word milestones.

Word production following walk onset was highly variable among infants (Figure 1). Nine infants were classified as earlier achievers for the 10-word and 50-word analyses, although the specific infants in each subgroup differed between each milestone. Age at walk onset did not differ between earlier and later achievers for either analysis (ps > 0.25). Infants who achieved the 10-word milestone earlier walked with smaller step lengths at 15 months compared to later achievers ($p = 0.031$), and a difference in walking speed approached significance ($p = 0.051$; Figure 2A). Similarly, earlier 50-word achievers had slower walking speeds than later achievers ($p = 0.034$; Figure 2B). There were no differences in step width between groups for either milestone (ps > 0.58).

Collectively, our findings indicate that infants who attained language milestones earlier produced less skillful walking patterns compared to those who did so later. These results suggest that there may be multitasking challenges that lead to behavioral trade-offs between motor and language development. Future research should explore when the switch in developmental priorities occurs (i.e., when earlier language achievers shift their focus to walking) and the implications of infants' multitasking for exploration and social interaction during everyday activities.

P2-A-223 - Methodological framework for using Inertial Motion Units in studies of infant movement and social interactions

Joanna Duda-Goławska [1], **Zuzanna Laudanska** [1], **Agata Kozioł** [1], **Karolina Babis** [1], **Anna Malinowska-Korczak** [1], **Przemyslaw Tomalski** [1]

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Details

Inertial Motion Units (IMUs) are increasingly popular for their cost-effectiveness and wearability in biomechanical analysis of limb and trunk movement. However, their application in infancy research requires a consistent, replicable analytical approach to ensure high-quality of data collection and pre-processing within a robust experimental setup.

Here we illustrate a methodological framework for the pre-processing and synchronization of accelerometer data from wearable devices with video footage. The study involved longitudinal data collection (n=80) in lab settings, with a focus on the development of infant vocalizations and limb movement during semi-structured play sessions between the caregiver and their infant (aged 4, 6, 9 and 12 months).

First, we present data on synchronization (at the onset of each 5-minute-long episode) using the caregiver-initiated hand-clapping movement, which was annotated in external video and audio tracks using extracted sound data. Synchronization between three external cameras and IMU sensors relied on these identifiable claps, present in both the audio signal and the caregiver's accelerometer data Fig 1.

Second, we present a pre-processing protocol for IMU accelerometer data, taking into account the effects of gravity, potential differences in IMU sampling rate and data losses.

Third, we present our approach to acceleration data using time-frequency analysis tailored for wearable IMUs. Fourth, we showcase our approach to the analysis of limb movements in relation to the infant's vocal production by quantifying the unique characteristics of vocalizations through a cochleogram Fig 2.

Finally, we discuss the technical limitations of this method and the potential effects of various data pre-processing decisions.

P2-A-224 - Mechanisms of reaching to the self and to the world through modeling on baby humanoid robots

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Details

We will present a set of embodied computational models on humanoid robots that address the mechanisms of reaching development in early infancy. We use humanoid robots with pressure-sensitive electronic skins covering large areas of their bodies, focusing on the somatosensory aspects of reaching development. First, we develop models of reaching to the self: starting from spontaneous touches to the bodies and corresponding motor-proprioceptive-tactile contingencies, algorithms are trained on this data and then tested by applying tactile stimuli to the robot bodies. Second, we study the development of reaching to objects external to the body. These are perceived visually, but we concentrate on the role of haptic feedback in learning the behavior on the robot. Such "somatosensory coding of space" connects reaching to the body with reaching to external objects. Third, we will present models of primary proprioceptive and tactile representations on the robot: the robot somatosensory homunculi. The robot performs "motor babbling" or is exposed to tactile stimulations on its whole body and the corresponding proprioceptive (joint angles) and tactile (from the artificial skin) activations are recorded. These are then fed into a self-organizing (or Kohonen) map algorithm and the representations that emerge are studied (see Fig. 1). Modifications of the standard algorithm that provide the right constraints to channel the learning toward the layout of the neural map observed in primate brains are

developed. Fourth, we use state-of-the-art computer vision techniques to extract body configuration from infant videos. The infant poses are then reattributed to an infant simulator, featuring vision and touch (see Fig. 2). This gives rise to a unique "first-person infant sensorimotor simulator" that generates data used to train artificial neural networks. This work is firmly grounded in collaboration with developmental psychologists and the scenarios the robots are exposed to closely follow concrete findings from behavioral studies in infants.

P2-A-225 - Infants' "developing" environment: How changes in infants' bodies and skills change their visual, tactile, and whole-body interactions with the world

Danyang Han [1], **Nicolas Aziere** [2], **Ori Ossmy** [3], **Hanzhi Wang** [2], **Ruiting Shen** [1], **Tieqiao Wang** [2], **Sinisa Todorovic** [4], **Karen Adolph** [1]

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Details

Many prominent researchers propose that infants generate their own input for learning through interaction with the environment—what they see, what they touch and where they go (e.g., Piaget, 1952; Smith et al., 2018; Kretch et al., 2014). On this account, infants' world is not a "blooming buzzing confusion" (James, 1890) because the world is filtered by their access. A long-standing hypothesis is that infants' growing bodies and sensorimotor skills expand infants' accessible environment and alter infants' self-generated learning experiences, but no research systematically quantified real-time and developmental changes in infants' visual, tactile, and locomotor inputs. Here, we aim to document how infants' immediate, accessible environment "develops" alongside infants' developing bodies and motor skills and the change in the structure of infants' self-generated learning input. Specifically, we precisely quantify how infants' visual, tactile and locomotor interactions with the environment unfold from moment-to-moment during natural activity and how the input changes in type and temporal structure over development.

To capture infants' natural activity, we video recorded them with 8 fixed, third-person views while they played in a calibrated laboratory playroom for 10 minutes. Infants wore no recording devices (e.g., head cameras, head-mounted eye tracker, inertial sensors). Caregivers were seated in the same room, occupied on their phone, and did not interact with infants. We observed 27 infants monthly (2-18 months) with varying levels of postural and locomotor skills for 115 sessions in total; see Figure 1 and databrary.org/volume/1020/slot/69224 for exemplar sessions.

We built a "virtual" playroom with 1:1 scale relative to the physical playroom from floor to ceiling (see databrary.org/volume/1020/slot/69221 for the physical and virtual playrooms). We used state-of-the-art computer vision algorithms ("InfantPose," Huang et al., 2021; "6DRepNet," Hempel, et al., 2022) to detect infants' feet, hands, head, and face orientations from the third-person video recordings. We custom-built an annotation tool for human coders to correct and improve the computer-vision estimation. We projected the detected "virtual" infant into the virtual playroom who "looked at" (based on head location and face orientation), "touched" (based on hand locations), and "visited" (based on foot locations) the virtual surfaces and objects. Because the virtual room tracks and records the location

of every surface and moveable object, fixed furniture, and the seated caregiver, we can automatically quantify every surface, object, human body, and scene in the infant's visual field. See Figure 2 and databrary.org/volume/1020/slot/69225 for processed visual, tactile, and locomotor interactions with the environment from one exemplar segment of infant play. We are in the midst of data analyses and results will be available by the time of the conference.

This is the first study to investigate how infants spontaneously create their own learning curriculum by quantifying how infants' interaction with the accessible environment changes as their bodies and skills develop. In addition, this study pioneers new forms of infant-activity detection based solely on the combined power of computer vision and human annotation from third-person video—without requiring infants to wear recording devices that might interfere with their natural behavior.

P2-A-226 - Tracking toddlers' motor development, where and when it happens

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Details

Infants acquire an astounding set of motor skills in a short amount of time: before their second birthday, nearly all can reach, crawl, and walk. The study of motor development thusfar has mainly relied on lab-based recordings, providing us with short snippets of data, while the actual motor skill learning takes place at home. Videos from home situations can now be analyzed with recently developed AI tools, which provides promising opporunities to study motor development 'in the wild'. However, those AI algorithms are typically trained on data from adults. Here, we put one of these freely available algorithms, FreiPose (Zimmermann, Schneider, Alyahyay, Brox, & Diester, 2020), to the test to investigate how accurate and generalizable this new method is when capturing toddlers' movements.

First, data will be collected in the lab, to test the accuracy of the algorithm when applied to toddler recordings. Three 20-month-old toddlers will play freely for 15 minutes, whilst being recorded with a new camera set-up. The set-up consists of three temporally synchronized and spatially calibrated cameras. This will result in 3 (toddlers) x 50 Hz (camera sampling frequency) x 15 (minutes) = 2250 samples, and each sample in turn consists of three images, namely one image from each camera viewpoint. The 2D location of the shoulder, elbow, wrist and hand of the dominant arm will be determined by visual inspection of every image, a process called labelling. Two-thirds of the samples will be used to train the algorithm, and the remaining samples will be used to verify the accuracy, by comparing the location of the body parts based on labelling and based on estimations of the algorithm.

Second, we will reuse an existing, unpublished dataset of videos from 58 toddlers (34 girls, mean age: 20 months) to test how well the now trained algorithm generalizes to videos from other toddlers in a different lab settings. Here, the veridical location of the body parts is known as the dataset contains motion-tracking data that was recorded in synchrony with the videos (see Figure 1).

Lastly, we will collect data from three toddlers playing in their own home, using the new synchronized camera set-up. This allows us to test how well the algorithm, trained on lab data, generalizes to home settings. Additionally, these videos will be hand-labelled as well, which allows us to test the accuracy of this method 'in the wild'. Importantly, we aim to explore the potential application of the algorithm to videos featuring even younger children in future research.

Lab and home data will be recorded respectively in January-February, and in March-April 2024. The near-fulltime avaibility of research assistance during that period allows us to thoroughly analyze the data well before the ICIS conference.

In summary, we will report how accurate, in terms of spatial precision, and how generalizable this promising new method is across individual toddlers and lab-settings. This will provide a solid basis for researchers to decide whether and under what circumstances they want to use regular video feeds to study motor development.

P2-A-227 - Early intervention for the caregiver-infant dyad with neonatal abstinence syndrome: A case series

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Details

Introduction: Use of opioids during pregnancy can lead neonates to withdraw after delivery, a condition known as Neonatal Abstinence Syndrome (NAS). The management of drug withdrawal in neonates can necessitate prolonged stays in the Neonatal Intensive Care Unit (NICU) to manage withdrawal. This has a profound effect on the infant's ability to calm and interact with their caregivers and environment, move their bodies, and sleep. Physical therapy is standard of care in most NICUs to assist infants and families with interventions to optimize treatment outcomes for infants born with NAS and their caregivers.

Hypothesis: The following research questions were investigated (1) does a caregiver-infant educational intervention assist with the stabilization of neurobehavior and (2) improve motor development of infants with NAS; and (3) does the intervention improve the caregiver-infant interaction.

Methods: A non-concurrent multiple baselines across dyads (infant and caregivers) single subject research design (SSRD) was used to examine the efficacy of the intervention. This design matches individualized therapy practice of the infant-caregiver dyad in the NICU with its contribution to evidence-based practice in a specific setting with a specific population (Lobo et al., 2017). A fidelity checklist was used to reflect the steps of the intervention's delivery and to ensure it was delivered in the intended manner. Fidelity was checked during 25% of all intervention sessions with the criterion set at 90%. Inter-rater reliability was established and collected on 25% of outcome measure testing with the criterion set at 85%.

Intervention: The intervention consisted of the systematic delivery of two phases. Phase one entails caregivers learning their infants' cues and helping to calm their infant. Phase two entails gross motor play to enhance motor development (Table 1). The dyads moved from phase one when items from the intervention were mastered with 75% correct identification of infant state and cues.

Outcome Measures: The outcome measures include the NIUC Neonatal Network Scale (NNNS), the Test of Infant Motor Performance (TIMP) and the Dyadic Mutuality Code (DMC) (Table 1). The NNNS was the primary dependent variable in the study. Baseline measurement was conducted three times, in a non-concurrent manner, across different dyads to establish baseline phase. At least 3 out of 12 atypical NNNS subscale scores (5 or 95 percentiles) were chosen to establish baseline prior to the intervention. The TIMP and DMC were given at baseline. All three-outcome measures were used between the intervention phase and at discharge.

Results: Figure 1 provides a visual representation of the data.

Conclusion: This innovative intervention used in the hospital NICU setting with infants and caregivers displayed significant effects. Dramatic decreases in atypical neurobehavior and increases in infant motor performance and infant caregiver interaction were seen across all four dyads. The findings of this study could serve as a framework for those working with infants with NAS and their caregivers as strategies to ease the transition between hospital to home and for measuring changes in motor, neurobehavior, and infant caregiver interaction.

P2-A-228 - The effect of environmental affordances on hand-use “preferences” in infants with impaired upper extremity functioning

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Details

Background. Infants and young children with weakened or impaired upper extremity functioning often develop a strong hand-use “preference” for reaching and object manipulation. While “preferring” their stronger hand, they often partially or completely ignore their “non-preferred” hand. Such manual lateralization might impede complex (e.g., bimanual) object exploration, which would negatively affect children’s cognitive development. The goal of the current study was to test the effect of environmental affordances on manifested hand-use preference during early development in infants with motor impairments. We hypothesized that the Playskin Lift™ exoskeletal garment (Playskin), providing anti-gravity assistance to infants’ arms, would improve infants’ ability to reach for and explore objects, making it easier for infants to use both the preferred and the non-preferred hand, which might lead to significant changes in their demonstrated hand-use “preference” and quality of play. **Methods**. The sample included 17 infants (5 males; 13.9 ± 8.7 months at baseline) with arthrogryposis multiplex congenita (arthrogryposis). Infants’ reaching and object exploration were evaluated longitudinally across a 6-month period with and without the Playskin. During testing sessions, infants participated in a reaching assessment – reaching for an object at hip, chest, and eye level (60 sec each, 180 sec total), and an object exploration assessment – free-play with toys when seated on the floor (5 minutes). Videos of

assessments were coded using Datavyu software to identify the duration of object contact and manipulation for each hand. Filemaker software was used to determine the intensity, variability, and complexity of infants' exploration. Additionally, the direction and strength of infants' hand-use preferences were calculated. **Results**. Use of the Playskin increased both unimanual (24.67%, p = .005) and bimanual (32.33%, p = .035) object contact. Also, when anti-gravity support was provided to the arms by the Playskin, infants significantly increased use of their non-preferred hand 86.66% (p = .001) for object contact in the reaching assessment, and 35.62% (p < .001) and 63.36% (p = .007) for object contact and object manipulation, respectively, in the object exploration assessment. The increase in the percentage of non-preferred hand use, in turn, significantly correlated with improved quality of infants' object play: more bimanual object interaction (p = .001) and greater intensity (p = .008), variability (p = .007), and complexity (p = .004) of exploration were observed. **Conclusions**. These findings suggest that hand-use "preference" in infants with arthrogryposis is quite malleable during early development. It is likely that infants with impaired upper extremity functioning do not "prefer" to use a particular hand but, rather, cannot afford to use both hands due to their limited perceptual-motor abilities. Importantly, environmental affordances (i.e., anti-gravity support for the arms) might significantly affect early development of manual lateralization, with potential implications for infants' quality of object exploration and future cognitive development. This research was supported by NIH grant 1R21HD076092-01A1.

P2-A-229 - Oxytocin Receptor Single Nucleotide Polymorphisms are Related to Maternal-Infant Co-occupation and Infant Sensory Processing

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Details

Background: Reciprocity is defined as "joint engagement between infant and caregiver and bidirectional temporal symmetry in actions and psychological states" (Aubuchon-Endsley et al., 2021, p.1) based on decades of theoretical and empirical work. Reciprocity impacts multiple developmental domains (Rocha et al., 2020). However, less is known about infant/toddler sensory processing, which impacts important developmental (Mueller, 2023) and health outcomes (e.g., sleep; Gee & Aubuchon-Endsley, 2023) through salient co-occupations (e.g., breastfeeding; Gee et al., 2021). Co-occupational variables may interact with prenatal biological risk factors to influence infant development. Promising genetic markers like oxytocin receptor (OXTR) single nucleotide polymorphisms (SNPs) are associated with empathy, prosocial behavior, maternal sensitivity, and neurodevelopment (Baribeau et al., 2017; Christ et al., 2014; Kajanoja et al., 2022). This may be due to alterations in oxytocin plasma levels, regulation of gene expression, and/or oxytocinergic neurons (Meyer et al., 2022). Altogether, these developmental risk markers may contribute to altered offspring behavior, which contributes to and is shaped by maternal-infant interaction quality. Therefore, this study investigates whether there are differences in maternal-infant co-occupational behavior and infant/toddler sensory processing based on risk alleles for OXTR SNPs rs53576 (A), rs2254298 (A), rs1042778 (G).

Methods: Data were from the Infant Development and Healthy Outcomes in Mothers Study (HSC approved protocol 4191), a longitudinal study conducted from 2015-2018. Participants provided saliva samples at 33-37 weeks gestation. DNA from these samples were extracted, purified, amplified, and assayed for the OXTR SNPs using a TaqMan SNP Genotyping Assay. Participants returned when infants/toddlers were 6, 10, 14, and 18 months (±2 weeks) of age. Maternal-infant co-occupation variables were continuously coded at the 6-month visit including frequency and mean duration of reciprocal emotionality, intentionality, and physicality (see Pickens & Pizur-Barnekow, 2009 for description) from 7-minute free play sessions. Mothers completed the Infant/Toddler Sensory Profile 2 at 10-, 14-, and 18-month sessions, leading to categorization of infants/toddlers' responses as within or outside the range of scores attained by the majority of same-aged infants in the standardization sample for each sensory pattern (i.e., Seeker, Avoider, Sensor and Registration/Bystander; Dunn, 2014). Point-biserial correlations were used to examine allele-group differences in reciprocity variables. Chi-square tests of independence were used to examine relations between allele groups and sensory processing.

Results: There were differences in frequency of emotionality (rs53576, rs2254298) and intentionality (rs2254298) and mean duration of physicality (rs1042778; see Table 1). There were different proportions of infants outside the majority range of sensation avoiding based on allelic configuration (rs53576, $\chi^2(1)=4.22$, $p=.040$) despite a non-significant odd's ratio ($OR=11.0$, $z=1.56$, $p=0.118$). Differences were not always in the predicted direction, which may inform future research.

Conclusion: Findings further support complex relations between OXTR SNPs and maternal-infant reciprocity and extend literature to important co-occupation facets while preliminarily supporting associations between OXTR SNPs and infant sensory processing/preferences. More studies need to examine these relations in larger, more diverse samples to examine whether allelic configurations mediate or moderate relations between maternal-infant co-occupational behavior and infant sensory processing/preferences.

P2-A-231 - Temporal dynamics of infants' limb activity during vocalizations - a longitudinal analysis

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Details

Objective: Vocal production is a complex motor action that requires the coordination of breathing with the activity of multiple muscles along the vocal tract. Relatively little is known about the early development of speech-like vocalisations in infancy, particularly with respect to their ability to produce such complex motor actions during social interactions without generating the overflowing activity of limbs. Here, we investigated whether infants co-activate their limbs (arms and legs) around the onset of speech-like vocalisations.

Method: We measured limb acceleration longitudinally (4, 6, 9 and 12 months of age, n=80) using Inertial Motion Units attached to infants' ankles and wrists in lab settings under different task demands (three interactive games: booksharing, toys affording manual actions and rhythmic rattling task). Limb

acceleration data was synchronised with individual video recordings from external cameras using custom procedure (parents performing multiple hand claps). The movement data were pre-processed, their individual envelopes calculated and epoched using custom Matlab scripts to produce mean acceleration plots for each limb (arms and legs) around the onset of each speech-like vocalisation. Speech-like vocalisations were manually annotated by trained coders. The validity of alignment between limb movement and the onset of vocal production was confirmed with spectral plots of audio recordings. We analysed the change in median acceleration of limbs in three time windows centred on the onset of a vocalisation: *baseline* (-750 to -500) ms, *pre-vocalisation* (-500 to 0) ms and *post-vocalisation* (0 to 500) ms. Hierarchical linear mixed model (with timepoint, task, limb and time window as fixed effects and participant as random effect) was used to conduct statistical analysis using lmer function from the *lme4* function in the R environment.

Results: The model explained >68% variance in the dependent measure (limb acceleration data), ICC=0.04 indicated that only a small proportion of variance was due to between-subject differences.

We found a significant main effect of timepoint (β= 1.28, p <.001), task (β= 0.05, p =.003) and crucially, of time window (β= 1.23, p <.001). The latter meant that the activity of both arms and legs increased significantly prior to the onset of a vocalisation and continued to increase after vocal production began. There were no significant differences in activation between arms and legs. Additionally, significant two-way interactions were observed, of timepoint and time window at 9 months (β= 0.28, p <.001) and 12 months of age (β= 0.26, p <.001), which indicated that limb activity increases were greater in the second part of the first year of life.

Finally, significant interaction of limb x timepoint indicated an increased activity of legs relative to arms at 6 months (β= 0.07, p =.045*)*, while at 9 and 12 months of age there was increased activity of arms relative to legs (9mo: β= –0.18, p <.001 and 12mo: β= –0.14, p <.001).

Conclusion: we found evidence for increased limb activity timed to the onset of vocal production during three different social interactive tasks with the caregiver. This effect was more pronounced at 9 and 12 months of age. This suggests that towards the first birthday infants learn to produce speech-like sounds by co-activating their arms and legs in synchrony with the vocal apparatus. Our findings highlight the late emergence of effector selection in early vocal actions.

P2-A-232 - Self-feeding and communicative development during the first two years of life: Concurrent and longitudinal associations

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Details

Early exposure to a baby-led weaning approach (BLW) encourages infants to actively participate in the feeding process, fostering the development of essential motor skills. By allowing them to manipulate, grasp, and chew a variety of age-appropriate foods, infants exposed to the BLW acquire a greater degree of autonomy in their eating experiences (Rapley, 2005, 2018). This contrasts with the parent-led weaning approach (PLW), where the emphasis on being spoon-fed puréed foods by a parent may limit the opportunities for infants to explore different textures and tastes independently. Notably, the developmental acquisitions in infants' motor skills may act as catalysts, shaping the caregiver-infant interactions during the daily feeding routines from the beginning of the weaning period and exerting an impact on the emergence of intentional communication by the end of the first year of life (e.g., Iverson, 2021).

In the present study, we observed a typical meal of 182 infants when they were 12 months of age, in order to investigate: i) whether infants' more advanced independent eating skills were associated with their emerging gestural and vocal communication, and ii) the relations between mothers' child-directed speech during the meal and infants' gestural and vocal production. We also examined the potential cascading effects of independent eating skills and mothers' child-directed speech on infants' language development at 18 and 24 months of age. Building on prior research (Camaioni et al., 2003; Weisleder & Fernald, 2013), we developed a coding scheme in order to capture infants' gestures and vocalizations, as well as all utterances and words directed towards the infants by individuals present during the meal. In addition to the observational measurements, mothers completed: i) a socio-demographic questionnaire, encompassing potentially relevant information, such as infants' age and gender, duration of exclusive breastfeeding, and the use of the pacifier, ii) the Italian short form of the MacArthur-Bates Communicative Development Inventories (Words and Gestures) (SF-MCDI) to assess comprehension, productive vocabulary, and gestures (Caselli et al., 2015), and iii) the Developmental ProfileTM 3 (Alpern 2007), from which we derived a fine-motor skill score. When infants were 18 and 24 months-old, mothers completed again the SF-MCDI (Words and Sentences).

Regression analyses revealed that infants who engaged in self-feeding more frequently during meals at 12 months were also more likely to exhibit deictic gestures (i.e., pointing, showing, offering, requesting and taking) and to produce a greater number of vocalizations than infants who self-fed less often. Moreover, we found that the proportion of mothers' child-directed utterances was positively associated with infants' production of gestures, vocalizations, and words. We also found that infants' fine-motor skills were positively related to their comprehension and gestures production at 12 months. Finally, longitudinal analyses showed that infants' self-feeding at 12 months was positively associated with their ability to produce sentences at 24 months.

Overall, these findings underscore the interplay between self-feeding, maternal child-directed speech, and the trajectory of infants' communicative development. The study highlights the importance of considering mealtime practices and interactions, as well as motor skill development, in understanding and promoting early language acquisition.

P2-A-233 - Modulation of infant's expressive signals during technoference

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Details

Introduction: Preverbal infants use multimodal signals to interact with their mothers (gaze, facial expressions, vocalization, and movements, Jover and Gratier, 2021). The mother's gaze is important during interaction and from this point of view, the contemporary multifaceted use of mobile phones constitutes a new developmental context for infants to develop communicative skills. The mother's attentional, but also visual, availability to her child can be frequently disrupted by a mobile phone – so-called the *technoference* (Abels et al, 2018; Radesky et al, 2014).

The present study aimed to examine whether 6-month-old infants modulate their communicative signals according to the availability of the mother's gaze and attention during *technoference* (Bourjade et al., 2023). More specifically, we sought to determine whether infants could adjust the nature and amount of their expressive signals (gaze, vocalization, facial expression, body movement) according to whether their mother was looking at them and/or using her mobile phone. To this end, we compared their expressive signals in a free-play situation and two *technoference* conditions: SMS and call. We expect infants to increase their multimodal signals during *technoference* as compared to the free-play condition. Furthermore, we expected infants to address visually inattentive mothers (SMS condition) with more auditory signals (vocalization) and to address auditory inattentive mothers (call condition) with more visual signals (body movements, facial expressions).

Method: 22 mothers and their 6-month-old infants were filmed during 3 interaction conditions, each lasting a minute and a half. The first was a free-play condition. Then two *technoference* conditions were counterbalanced. These consisted of a sudden interruption of the interaction by the mobile phone, on which the mothers had to perform a simple cognitive task either by text (SMS condition) or by voice (call condition). The mother was instructed to respond and behave as naturally as possible. The videos were analyzed using The Observer XT (Noldus™) software, using a grid to record the beginning and end of the mother's gaze toward the child, the infant's gaze toward the mother, vocalizations, and facial expressions. The movements of the infant's right leg were coded using software developed in our lab (Video Analyser; Mare, 2010). Coding reliability was controlled using Cohen's kappa. The protocol was approved by the university ethics committee.

Results: The infant's gaze depended on both the condition ($F(2,40)=8,49$, $p<.001$) and the mother's gaze ($F(1,20)=11,56$, $p<.005$): it increased when the mother was looking at the child and in the call condition as compared to the free-play condition. Facial expressions depended on both the *technoference* and the mother's gaze ($F(2,40)=3,68$, $p=.034$): they were more frequent when the mother was looking at her infant, in particular during the free-play condition. Vocalization duration was increased during *technoference*, in particular during the SMS condition ($F(2,40)=4,44$, $p<.05$). The body movements are currently being analyzed.

Conclusion. The results showed that 6-month-old infants modulated their expressive signals according to their mother's attentional and visual availability. The *technoference* constitutes an interesting protocol to test attention-sensitive communication in human infants (Bourjade et al., 2023).

P2-A-234 - Culture-specific experience with music: Effects on rhythmic motor engagement and synchronization

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Details

Synching body movements with music, whether through dance, clapping or tapping, is a common human behavior (Patel et al., 2005). Though seemingly effortless, synchronization with music requires the complex ability of inferring an underlying musical beat and integrating a rhythmic motor response into the inferred metrical framework (Kirschner & Ilari, 2014). Musical metrical structures vary across cultures. For instance, while Western music is mainly characterized by simple meters (e.g., 3/4, 4/4), Balkan or Turkish music frequently uses complex meters (e.g., 5/4, 7/8, etc.). Listeners undergo a process of music-cultural perceptual narrowing, i.e., they initially exhibit sensitivity to a broad range of perceptual structures, which narrows down through exposure to the specific characteristics of their musical culture, thus leading to reduced sensitivity to unfamiliar musical patterns (Hannon & Trehub, 2005).

Motor synchronization with music has been observed to be robust from 3 years of age (Provasi, & Bobin-B□gue, 2003; Kirschner & Tomasello, 2009). However, recent evidence suggests that even very young infants respond to music with specific motor behaviors that, although not yet fully mature, appear to underpin the ability to synchronize with music (e.g., Zentner & Eerola, 2010; Fujii et al., 2014). However, there is still little evidence about when infants start synchronizing to musical beat and if culture-specific exposure to music influences their movement-to-sound responses.

To address these questions, this study investigates whether (i) culture-specific perceptual narrowing influences how infants spontaneously move in response to music of their native meters as compared to unfamiliar meters; and (ii) whether these responses are modulated by daily exposure to a specific metric pattern, which is either native or non-native to the infants' culture.

To this purpose, 31 infants aged from 5 to 19 months, who are mainly culturally exposed to Western music with simple meters, were presented with songs of both simple (4/4) and complex (7/8) meters, while two accelerometers, one attached to the right wrist, the other to the right ankle recorded their motor behavior as a response to these songs. After the first testing session, they participated in a month-long musical training at home with either a 4/4- or 7/4-meter song. They then returned to the lab for a second testing session, identical to the first one (n = 23). Data analysis is ongoing. We will first analyze the linear correlation and synchronization between the two measured limbs within each participant. Subsequently, we will perform temporal coincidence analysis between the meter and beat of the musical stimuli and the peaks in limb motion, aiming at quantifying the synchronization of limbs with music as well as the synchronization between hands and legs in babies.

Overall, these results will bring important insights into the general understanding of the mechanisms underlying sensorimotor synchronization abilities with music, their development during the first year of life, and the role that cultural music ultimately plays in this specialization.

P2-A-235 - Age and crawling ability contribute to differences in infant visual preferences for familiar and unfamiliar faces

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Details

At 3-4 months, infants typically show visual preferences for familiar genders and races. These preferences might manifest so infants learn about and develop expertise in discriminating among familiar face types. However, such preferences decrease during the second half of the first year (e.g., Fassbender et al., 2016). This decrease may occur due to greater efficiency in processing familiar face types with age and a shift toward a preference for novelty as opposed to familiarity. Additionally, the time frame for this decline in visual preferences overlaps with typical changes in motor development. Specifically, as infants gain some autonomy with the onset of crawling, this change may influence who they look at and how they process faces. To explore this potential transition, we investigated how infant age and crawling ability predicted differences in infants' visual attention toward familiar and unfamiliar female-male face pairs.

We collected data from 194 (98 female) infants aged 5.5 to 10.5 months of age. During the week prior to testing, parents recorded their infants' daily facial experiences and completed a motor development checklist. During the study, infants viewed four female-male face pairs (two Black, two White) posing either neutral or pleasant expressions. We calculated the percentage of time infants looked at the female face relative to their total looking time toward both faces (female PTLT).

We compared three potential models to determine if age, crawling ability, or both provided the best fit to capture infant visual attention toward faces. We used SAS Proc Mixed linear mixed models and found the best fitting model included both age and crawling ability and resulted in a significant 5x3x2x2 [Age Group (6, 7, 8, 9, 10 months) x Crawling Ability (not crawling, in transition to crawling, crawling regularly) x Face Pair Race (Black, White) x Face Pair Expression (neutral, pleasant)] interaction, F (7, 166) = 3.04, p = .005, Cohen's f = .29 with four covariates (infants' percent experience with Black females, Black males, White females, and White males) to control for individual differences in experience with the face categories.

Results indicate that including both age and crawling ability produced the best fitting model, and that there was variability in infants' preferences toward female faces within each age group based on infants' crawling ability (See Figures 1 and 2 for examples of visual preferences in the neutral condition.) These results suggest that the variability in visual preferences that may occur within ages could be related to other developmental factors, such as transitions in motor development. Infants also showed different preference patterns based on the posed expression of the faces suggesting that facial affect may be an important consideration for capturing infant attention. Future research may consider using a systems approach when investigating infant visual attention to account for the potential impact of individual variability across developmental domains.

P2-A-236 - Infants stepping influences visual preferences for biological motion at 5 months

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Details

Research suggests that a large developmental shift happens between 3 and 5 months of age in the way that infants perceive the human walking action. At 5 months, infants perceive the motion of a person walking as a global coherent human body in action (Bertenthal, 1993; Moore et al., 2007). Conversely, at 3 months, infants seem to perceive the human walking at a smaller and more localized scale, demonstrating more sensitivity to the local motion of the limbs (Bertenthal, 1993). Considering the above, Lisboa et al. (2022) conducted a preferential looking experiment, examining 3- and 5-months old infants' preferences between an intact coherent point-light walker (PLW) and a scrambled PLW. Three months old infants preferred the coherent PLW (i.e., the only stimulus in which the motion of the limbs was intact). However, 5 months old infants showed no preferences. Considering the growing evidence indicating the existence of a bidirectional link between action perception and action execution during development (e.g., Reid, Kaduk, & Lunn, 2017), a plausible interpretation for this developmental process is that a preference for the coherent PLW might emerge later in development with walking experience.

To validate this hypothesis, the same experiment could be conducted with older walking 12 to 17 months old infants. Alternatively, walking experience could be given to 5 months old infants and an assessment of their preferences could take place.

In this study, we explore whether inducing the stepping reflex in 5 months old infants alter infant's preferences for a coherent walking action. We tested infants (N= 33, n=28) in a preferential looking procedure following a session where we induced a stepping reflex.

To induce the stepping reflex, infants were held upright by the experimenter under their arms with their feet in contact with a surface. The infant's head was tilted slightly forward relative to the body to elicit the stepping reflex (Thelen & Fisher, 1982). All infants traversed a standardized distance of 4m. This procedure was recorded for off-line coding of the number of steps per infant.

In the preferential looking procedure, a coherent and a scrambled PLW were presented simultaneously side-by-side in two computer screens. The dependent variable was the proportion of looking at the coherent PLW. Stimuli presentation to the right and left was counterbalanced per infant. Infants participated in a total of 12 trials of 20 secs each.

Our preliminary analysis has indicated a positive correlation between the number of steps performed by infants and their proportion of looking at the coherent PLW, $r(26) = 0.39$, $t(26) = 2.13$, $p = 0.021$. Infants who exhibited a greater number of steps during walking reflex induction demonstrated a higher proportion of looking at the coherent motion stimulus over the scrambled display – see Figure 1.

This result supports the notion that infants' own action experience is related to how they perceive and visually select observable actions. This also challenges the previous notion of a lack of preference for PLWs in 5-month-olds, suggesting that this lack of preference might be due to an immature walking experience rather than to an inability to perceptually discriminate the two stimuli. The implications of these findings extend beyond the realm of basic perceptual preferences, shedding light on the intricate connections between motor milestones and infants' visual experiences.

P2-A-238 - How dyadic positions modulate infant-caregiver behavior coordination during object play

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Details

Object play with a mature partner is both a prominent activity of infants and the focus of considerable research in the developmental sciences. Previous studies have demonstrated that behavioral coordination within or between individuals during object play contributes to infant object recognition, joint attention, sustained attention, and word learning (Schroer & Yu, 2019; Slone et al., 2019; Yu & Smith, 2013, 2016). In the typical laboratory setting, dyads sit face-to-face at a table or on the floor to play. However, infants and their parents do not always position themselves in front-to-front play in everyday life (Schneider & Iverson, 2022). Other spatial positions (on lap, side by side) change the visual information available to both partners and may change the nature of the interaction in meaningful ways. In the current study, we experimentally manipulated the spatial arrangement of the two partners in play and measured multiple aspects of behavioral coordination.

The full sample will consist of 45 infant-caregiver dyads (infants 16- to 27 months, the present report is based on 16 dyads). Both infant and caregiver wore head-mounted cameras while playing with 2 different sets of 3 toys (sea animals and mealtime objects) for 6 minutes. Each dyad was randomly assigned to front-to-front, side-by-side, or infant on-lap play. In all conditions, the play took place on a small table.

The main findings are these: The arrangements influenced caregiver views more than infant views (who primarily looked at the toys and hand actions on those toys). The proportion of infants' faces in the caregiver view was high in the front-to-front condition but minimal in the other two spatial arrangements. Hands – their own hands and infant hands – were more visually dominant in caregiver views in the front-to-front condition than in the other conditions. In the front-to-front condition, caregivers were more likely to coordinate their labeling utterances with objects that the caregivers were handling. In the other conditions, caregivers labeled objects being handled by their infants. The number of caregivers' labeling utterances was comparable between conditions, but infants vocalized more frequently in the front-to-front conditions than in the other conditions.

These results indicate that dyadic position modulates how infant and their caregivers interact in play. Although front-front play has the hallmarks of interactions that studies in the past have shown to support social interactions and learning, the other arrangements have not been systematically studied and may have their own advantages or unique interactive paths to quality social interactions.

P2-A-239 - Associations between vocabulary and motor development in early childhood: Differences between verb and noun understanding

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Details

Verbs are hard to learn. Children acquire verbs later and less frequently than nouns (Gentner, 1982). This disparity is largely driven by differences in the concepts verbs and nouns denote (Gentner, 1982; Gleitman & Gleitman, 1992). Nouns often describe concrete, perceptually-stable objects that children individuate with ease. Whereas verbs often refer to abstract actions that are fleeting and unfold over time. Yet, children begin learning some verbs early in their development and go on to acquire an impressive verb lexicon (Fenson et al., 1994). Children likely use several mechanisms to help them identify verb referents. One possible source of information may be infants' own motor actions. Here, we suggest that children's developing motor abilities play an important role in their verb acquisition. One reason why this link may exist is that infants' newly acquired motor abilities have been found to create novel opportunities for infant-directed verb labelling (West et al., 2022, 2023). Several theoretical perspectives support the view that changes in infants' motor ability play a role in their language acquisition (Iverson, 2010; Oakes & Rakison, 2020; Thelen & Smith, 1996). Consistent with this proposition, many studies report strong positive associations between motoric gains and vocabulary size during infancy (Gonzalez et al., 2019). However, these studies have only explored relations between motor development and overall vocabulary measures, which are typically noun dominated. Here, we investigated whether motor development is differentially associated with verb versus noun comprehension across the first two years of life. If children's own developing motor abilities do play an important role in their developing verb knowledge, then we might expect to find that the relation between vocabulary and motor skills is stronger for verbs than for nouns. We asked 82 parents of 6- to 24-months-old to complete the Oxford-CDI (Hamilton et al., 2000) and the EMQ (Libertus & Landa, 2013). As we propose that motor abilities play a role in verb acquisition, we included additional verb items in the Oxford-CDI that describe some of the early motor actions and gestures infants learn to perform (e.g., clap, crawl). To explore the relation between children's motor development and word knowledge, we fit a logistic mixed-effect model with comprehension for verb and noun items as a binary outcome variable (0 = does not understand, 1 = understands or says). EMQ scores and word type (verb | noun) and their interaction were entered as predictors; age was included as a covariate. We found a significant interaction between motor skills and word type (B = -0.37, CI 95% [-0.65, -0.09], SE = 0.14, z = -2.62, p = .009). Follow-up analyses revealed that the association between motor skills and proportion of words understood was significantly stronger for verbs than nouns. This is the first empirical study to provide evidence linking motor gains with emergent verb knowledge, a key tenant of many embodied language theories. These findings also showcase how the EMQ can serve as a predictor of language development, by capturing broad individual differences in infant motor ability (Smith & Libertus, 2022).

P2-A-240 - Infant manipulation complexity and caregiver object labeling during play

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Details

Objective: Object play in naturalistic environments affords rich opportunities for infant learning. During play, caregivers are more likely to label an object when the infant is actively manipulating an object. Moreover, objects manipulated by infant and/or labeled by the caregiver are more likely to appear in

infants' vocabularies and spontaneous speech patterns when compared to objects that were not manipulated by infants or labeled by the caregiver during play. However, infants manipulate objects in complex ways that have not been captured by prior studies relating infant motor skill level and caregiver language input. Infants use different combinations of fingers, different roles for each hand, and will deconstruct object parts—this study introduces these fine-grained differences as the construct *manipulation complexity (MC)*. Through a cumulative ranking of skills performed by the infant on different objects, children can be grouped into "high" or "low" MC. Infants with high MC use more difficult manipulation skills relative to those with low MC. The objective of the current study is to examine if the frequency of caregivers' object labeling varies as a function of infant MC during object play. Alternatively, we will examine whether differences in infant MC are related to differences in opportunities for fine motor skills in the home.

Methods: The study is preregistered on OSF (https://doi.org/10.17605/OSF.IO/JXAGY). We are recruiting 40 caregiver-infant dyads through the Children Helping Science platform powered by Lookit. In this remote design, infants must be 12-months-old to 18-months-old (+/-14 days). The study is divided into two activities: a 10-minute caregiver-infant play session and the administration of the Affordances in the Home Environment-Infant Scale (AHEMD-IS) and demographics questionnaires. The play session is recorded, and the caregiver is instructed to play as they normally would using a battery of 3 pre-approved objects from a list provided to caregivers in advance. MC is coded from video using 10-sec interval sampling using an 8-point scale that is based on four contrasts: (1) unimanual or bimanual manipulation; (2) synchronous or asynchronous use of the hands; (3) dependent or independent finger use; and (4) whether manipulation involved more than one object simultaneously. We will categorize infants as "high" or "low" manipulation complexity from a median split on average scores. Sessions are also being transcribed to determine frequency of caregiver object labeling (i.e., number of labeling utterances that occurred during infants' object manipulation divided by the total number of labeling utterances).

Data Analytic Plan: Independent samples t-tests will be used to test our two hypotheses. If caregivers change their language input based on their infant's manipulation skill, the frequency of object labeling will be higher in infants with high MC relative to infants with low MC (**Fig. 1**). If instead infant's manipulation skill is a result of fine motor opportunities available in the home, infants in the high MC group will have a higher AHMED-IS fine motor score relative to infants in the low MC group (**Fig. 2**). We expect data collection and analyses to be complete by ICIS 2024.

P2-A-241 - The development of the infant vocal tract: an ultrasound study

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Details

Orofacial anatomy changes during the first year of life, and infants start to develop control over their articulatory gestures and explore these via vocal productions such as babble. The auditory signal has been the locus of the vast majority of research into early vocal development to date, since studying dynamic articulatory movements in the developing vocal tract is relatively difficult. To bridge this gap, we provide

an innovative proof-of-concept study that uses ultrasound imaging to analyse the developing infant vocal tract and tongue movements.

In the first phase of our study, we collected ultrasound data from 12 infants aged 6-12 months. Subsequently, these infants participated in 2-3 follow-up sessions at varying intervals after the initial session. The objective of this first phase was to create a rigorous, feasible, and effective experimental protocol that would yield sufficient data for analysis and be enjoyable for our participants. The active collaboration of parents was valuable in optimising our method; parents ensured that their children felt at ease and even contributed creative suggestions, which allowed us to collect higher quality ultrasound images and, sometimes, to exceed our planned quota. In the second phase, we piloted the protocol with infants from a broader age range (6-17 months) and obtained data that provide a novel longitudinal mapping of the infant vocal tract. These testing sessions were promising: infants tolerated the ultrasound probe well, especially at younger ages, and we were able to get scans of swallowing, feeding (bottle, snacks and breastfeeding), and vocalisation gestures.

In this poster, we share our experiences, evaluate our experimental protocol and analysis methods, present preliminary analyses of our pilot data, and outline the avenues that we will explore next. The method that we have developed offers great potential for investigating how infants refine their articulatory gestures, and provides unique insights into an underexplored area of vocal development research.

P2-B-242 - # Analysing baby jokes - An open test case for automated analysis of parent-child interactions

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Details

Recently, we trained a machine learning model that can predict high and low synchrony in a small dataset of expert coded parent-child interaction videos with 72% accuracy (Stamate et al. 2023). Building on this work we are developing a system that can automatically analyse PCI videos to predict expert ratings of parental warmth, sensitivity and responsiveness. This is ethically sensitive topic and there are data sharing protection issues related to PCI video datasets. Therefore, in order to share our code and methods openly with other researchers we have developed the Baby Jokes demonstration project presented here.

The project currently allows the automatic labelling of identity, movement, facial expression, speech and laughter (Figure 1) and provides tools to evaluate machine learning model outputs (Figure 2). Model development is still underway and a full analysis will be presented at the conference.

Dataset
The dataset of short videos (10-20 seconds) of parents demonstrating five simple jokes to their infants was collected on the MIT Lookit platform for another project. A subset of parents agreed to share their

data resulting in a dataset of 1426 videos from N = 93 parent-child dyads (infants - 39 female, 54 male, ages 122-901 days). Dataset available on request.

Models and code
Pose estimation keypoints are generated with state-of the art open-source models including YOLOv8 (Jocker et al, 2023), facial expression with DeepFace (Serengil and Ozpinar, 2021), and speech recognition with Open-AI Whisper (Radford et al 2022).
All code is freely available with an MIT open source licence at github.com/infantlab/babyjokes

Results and conclusions
Classification results will be presented at conference.

P2-B-243 - How mothers perceive toddlers' difficult temperament and its relation to engagement in smart device use

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Details

Device Use (15 단어/15 단어 max)

In this mobile world, children are already attentive to surrounding media and they turn into relatively competent users of technologies even at the very young age. As toddlers' gradual development has been highly affected by smart devices, the role of parenting has been considered as one of the influential factors in its relation to children's media practice (Kabali et al., 2015). It seems like parents are getting aware of the impact of this portable and instantly accessible source of smart devices on their children, but the research related to both negative concerns and potential outcomes for young children needs to receive more attention. Among them, mothers' positive perception of the impact of media on their young children's development, in special, may lead to their greater use of media as a parenting tool, and this may finally result in young children's engagement in smart device use.

Although parents are more likely to have a power to control young children's media use, different parenting techniques may work effectively for different children, given their various traits and temperament. It is suggested that parents' motives for media use for their young children likely vary based on a child's individual differences. As a result, the active use of smart devices for young children can be determined by their own temperament, and by the mothers' perception towards children's media use. Therefore, the purpose of this research is to address the moderating effect of mothers' perception of the impact of smart devices on young children's development in relation between toddlers' difficult temperament and their engagement in smart device use.

The sample consisted of 215 Korean young children aged in between 24 to 36 months enrolled in 18 childcare centers in Korea. Toddlers' difficult temperament (Abidin, 1995), their engagement in smart device use (Lee, Jung, & Kim, 2015) and mothers' perception of the impact of smart devices on their children's development: physical, emotional, social, language and cognitive development (Kwon, 2005) were assessed by mothers. Hierarchical regression analyses were performed to examine the relations among variables. Children's month, sex, first time of using smart devices, and daily duration of smart devices use of toddlers were considered as covariates. Interaction effects were detected as illustrated in Figure 1.

Toddlers' difficult temperament was significantly associated with their engagement in smart device use, and the association was moderated only by mothers' perception of the impact of smart devices on their children's emotional development, whereas physical, social, language and cognitive development were not. Findings from this study suggest that when mothers' have more positive perception of the impact of smart devices on young children's emotional development, children become more susceptible to their engagement in smart device use. Based on results, implications related to the parents' zeal for promoting young children's emotional development from early years of life, which is essential to preparing for toddlers' future success in current digital world, will be discussed more in depth.

P2-B-244 - An early stimulation program for manual skills: a pilot study

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Details

Manual skills are a fundamental tool for infants to explore the world, communicate, and express their desires. Acquiring manual skills at an early age afford infants opportunities to explore regularities in their encounter with the world even before being able to show independent instrumental use of reaching and grasping. However, caregivers at home and in early infant care centers are not aware of the need for promoting fields of action for young infants to their hands in actions even before they are instrumental. The aims of this study were to offer a program to stimulate early manual skills in infants from 1 to 3 months old during daily care practises; to measure the mothers' adherence to the program; and to describe the beliefs about motor development of the mothers who applied to the program. 4 dyads of mothers and their infants participated (= 3.5 weeks old, sd= 0.5). Before starting the 8-week program and after finishing it, the General Movements (GM) scale was used to evaluate infants' motor development. Mothers had access to a closed Instagram profile with video clips describing the stimulation activities in the following categories: manipulation, sensorial massage, auditory contingency and accidental touch, that should be done during bath, diaper changing, sunbath, and breastfeeding. Adherence to the program was obtained by a questionnaire sent daily to the mothers. Also, mothers answered the Parental Beliefs on Motor Development (PB-MD). The results show that infants received = 58 days of stimulation (sd=11.31) during 8 weeks. The activities were most offered during diaper changing (= 25.5, sd= 2.5 times), followed by breastfeeding (= 18, sd= 13.21), sunbath (= 16.25, sd= 8.30), and bath (= 15.5, sd= 11.6). The number of repetitions per day was 1-2 times/day (= 13.5, sd= 12.3); 3-4 times/day (= 7.7, sd= 8.0); 5-6 times/day (= 6,25, sd= 5,9); 7-8 times/day (= 2.5, sd= 4.3); 9-10

times/day (= 2.2, sd= 4.5). The total hours of stimulation for each participant were as follows: participant 1 (10.16h), participant 2 (3.46h), participant 3 (4.7h) and participant 4 (0.8h). The PB-MD showed that 100% of mothers considered motor development one of the most important thing in the first years of life, 50% believed that motor development needs stimulation, and 25% believed that it does not. No mothers believed that the milestone must be reached as soon as possible, and all mentioned that infants do not need tummy time and especially if they cry. The infants showed independent reaching between 7-8 weeks old. The results show that regardless of individual dyadic differences, all mothers adhered to the stimulation activities during daily care practices. Even though the stimulation did not anticipate the achievement of reaching milestone, young infants had the opportunity to use their hands to explore objects and contingent relationships through the stimulation program. Informing parents of this practice can improve child rearing practices for typical babies, and this can be an early intervention tool for at-risk infants.

P2-B-245 - From key points to key insights: Probing infant motor development with different computer-vision algorithms

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Details

Motor development stands as a pivotal element in the realm of infant studies, with the nuances of movement during developmental stages serving not only as markers but also as potential diagnostic features. The traditional approach taken by clinicians involves the use of developmental surveys and test batteries (e.g., PDMS-2, Vineland, and Bayley), which introduce an inherent examiner subjectivity.
As technology continues to advance, computer scientists have responded with the introduction of automatic movement detection methods, a promising avenue that increases accuracy, practicality, and ecological validity.
Despite the potential benefits of automatic technologies, controversies and concerns about their functionality persist particularly when applied to natural settings. This study addresses these concerns by undertaking a comparative analysis of two prominent algorithms used in human movement detection: OpenPose and MediaPipe. These algorithms are developed to detect human poses in real-time, with OpenPose being known for its robustness in recognising human body keypoints and estimating their poses. With models trained for COCO (Common Objects in Context) and Body-25 points, OpenPose has found extensive applications in various fields, including sports analytics, healthcare, and human-computer interaction. However, what sets MediaPipe apart is its lightweight structure and flexibility. MediaPipe provides different trained models (Lite, Normal and Heavy) allowing users to choose based on their specific requirements. MediaPipe has documented application in infant studies remains limited. This study seeks to employ these techniques to investigate infant motor action.
To provide a comprehensive evaluation, our study will specifically focus on comparing specific, isolated movement detections. To bridge the subjective evaluation of behaviour and the automated coding of MediaPipe and Openpose, we employ Datavyu software, a non-automatic tool traditionally utilized in

movement studies, to serve as a reference for movement detection by automatic detections.
This study provides in-depth movement analyses that extend beyond mere detection and provides specific evaluations of velocity, acceleration, duration, and range of motion isolated to the right elbow of 30 newborn infants employing Datavyu alongside MediaPipe and OpenPose detections.
Our findings will demonstrate that the automated coding is validated by our manual coding method (Datavyu), but more importantly, our findings highlight that Mediapipe, is faster and provides 3D coordination for each marker and OpePose's trained model has modifications for infant pose detection.
Ultimately, through this comparative analysis, we seek to inform researchers, clinicians, and practitioners about the most effective tools for pose detections in infant studies, potentially shaping future research methodologies in this crucial field.

P2-B-246 - Visual attention development in infancy

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Details

Eye-movements are a valuable source of information, next to responses and response times, for inferring cognitive states and processes. Infant research depends on eye-movements to a large extent as other behavioral response modalities are hard to use in this population. Eye-movement data comes with many challenges, many basic properties are not well-known or understood. Optimal methods for defining fixations and saccades are still under muchdiscussion. Free viewing presents a good way to study infant visual attention and provides robust developmentaltrends for a number of phenomena. We present several studies that use free-viewing to study i) general biases such as horizontal and central bias, ii) the shift from saliency-based to object-based viewing, and iii) the relationship with individual differences variables. For example, Figure 1 shows the correlation of perceptual salience with the number of fixations on a particular location and the rank order among all fixations. The influence of salience decreases with age and is replaced by object-based viewing.

These results form an interesting target for computational modeling, for which we propose an information accumulation model. This model purports to explain i) fixations durations and ii) the choice of the next location to fixate on. The model does so by assuming a competitive process between i) information uptake at the current location and ii) the possibility of finding locations of interest elsewhere. The model combines the effects of general biases and the shift from saliency-based to object-based viewing. Figure 2 shows observed fixations in a free-viewing task and model-predicted fixation locations. The model performs well in predicting durations and locations. We discuss the implications and possible extensions of the model.

P2-B-247 - Advancing the uptake of community autism early intervention with the use of implementation frameworks

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Details

Background: The extent to which the benefits documented in early intervention efficacy trials are realized in community settings is critical to the autism field. When interventions have been conducted in community settings, the research reports contain little information about what supported or detracted from success. As a result, adopting new or innovative approaches to early intervention service is often undertaken using a 'train and hope' approach with limited considerations of the processes and supports that will help it succeed.

Objective: This case study aimed to explore the community implementation of a parent-mediated early intervention of very young children at risk for autism, the Parent and Child Early (PACE) Coaching project. Two frameworks guided our implementation approach: the National Implementation Research Network (NIRN) Stages of Implementation (Fixsen & Blasé, 2008) and the Consolidated Framework for Implementation Research (CFIR; Damschroder et al., 2009).

Method: The NIRN and CFIR frameworks guided the project administration, data collection methods, and subsequent analyses. Interview data were collected from participants at three time points: before the project, after coach and autism screening training, and after community implementation of PACE Coaching. At each point, interviews were transcribed and coded deductively using definitions of CFIR constructs. Analyses across project activities were conducted to identify common CFIR constructs that enabled or challenged the implementation of PACE Coaching.

Results: Fourteen Child Development Centres (CDCs) or Aboriginal service agencies across British Columbia, Canada, participated from 2017-2021. Comparative analysis identified seven factors that were common across the activities of the project and positively contributed to implementation: *relative advantage* (Program Characteristics), *client needs and resources* (Outer Context), *networks and communications* (Inner Context), *learning climate* (Inner Context), *leadership engagement* (Inner Context), *knowledge and beliefs about the intervention* (Individual Characteristics), and *formal appointment of implementation staff* (Process). Factors that consistently detracted from the project activities were less frequent; these included *complexity* (Program Characteristics) and *recruitment and retention of participants* (Process). There was high agreement among participants that the practices of PACE Coaching were beneficial and valuable and that the training model was comprehensive and transformative. Findings suggest that practice change was highly variable among community participants and emerged gradually with the support of trainer consultation and family practice opportunities.

Conclusions: This case study demonstrated the utility of an implementation approach to supporting and improving the quality of early intervention services for children with (suspected) autism and their families in community settings. We learned from this case study that practitioners are motivated to learn evidence-based interventions and implement them despite their large caseloads and the

complexities of the families they serve. Attending to implementation science frameworks strengthened our efforts to plan a complex yet evidence-informed service in diverse community settings.

P2-B-248 - Does infant respiratory sinus arrhythmia and visual attention predict ADHD and ASD?

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Details

Early identification of attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) is imperative for mitigating impairment and optimizing outcomes across the life course (Hirota et al., 2021). Respiratory sinus arrhythmia (RSA) and RSA reactivity (task-based change in RSA from rest) are well-established indices of parasympathetic nervous system activity utilized in studies of youth with both diagnoses. These studies yield mixed results such that youth with ADHD and ASD tend to demonstrate lower RSA at baseline and elevated RSA withdrawal during attentionally and socially demanding tasks, respectively (e.g., Morris et al., 2020; Ward et al., 2015; Tonhajzerova et al., 2009). To our knowledge, no study to date has examined RSA in a sample of infants at elevated and/or average familial risk for ASD or ADHD during tasks relevant to attentional and social challenges. Infants and young children developing ASD or ADHD may exhibit distinct patterns that could serve as early behavioral and physiological indicators of these conditions (Beauchaine et al., 2015; Catai et al., 2020). The present study examined a sample of 90 infants (36 females; 82.2% Non-Hispanic) with a parent or older sibling diagnosed with ADHD (n=30), ASD (n=36), or neither (n=24). Heart rate data were collected at 12 or 18 months of age during a baseline condition and a split-screen, eye-tracking task of dynamic social stimuli and (non-social) moving objects, from which RSA was derived. Eye-tracking data were derived to capture general sustained attention (proportion looking time to the whole screen) and social attention (proportion looking time to the social stimuli). At 36 months of age, participants were classified into one of three outcome groups: ADHD Concerns (n=21), ASD (n=12), or Comparison (i.e., non-ASD/non-ADHD Concerns; n=57). Consistent with hypotheses, infants who later received ADHD Concerns outcome classifications exhibited significantly less whole-screen looking time at 12 or 18 months of age (M=0.63, SD=0.24) than the Comparison group (M=0.80, SD=0.17), but did not differ from those who later received a diagnosis of ASD (M=0.73, SD=0.23; $F(2,87)=5.96$, $p<.05$). Further, infants with ADHD Concerns (M=0.51, SD=0.16) or ASD (M=0.51, SD=0.20) outcomes spent significantly less time attending to the social portion of the stimulus than the Comparison group (M=0.61, SD=0.14; $F(2,87)=5.96$, $p<.05$). Contrary to hypotheses, baseline RSA did not differ by outcome group, $F(2,87)=0.315$, $p>.05$ nor did degree of task-based RSA change, $F(2,87)=1.26$, $p>.05$. RSA reactivity did not moderate the association between diagnostic outcome and whole-screen looking time or looking time to the social stimuli (all $F<2.96$, $p>.05$). While the present findings do not support the utility of RSA as an early biomarker, sample sizes were small. Data collection is ongoing in a larger, independent sample. Results demonstrated distinct patterns in visual attention as early as 12-18 months of age among infants developing ASD or concerns for ADHD. This study paves the way for impactful early identification research, as the current median age of diagnosis for ADHD is 6.2 years, and 4.1 years for ASD (Maenner et al., 2023; Miller et al., 2019).

P2-B-249 - Speech Samples Assessing Mother-Infant Emotional Climate during Infancy

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Details

Although the emotional climate in the family has been consistently associated with the development of psychological disorders in childhood and adolescence, its presence in the first year of life remains largely unexplored. The Five Minute Speech Sample (FMSS) is a widely used method for assessing emotional climate in an economical and reliable way, but its use in infancy has been so far limited. By analyzing the verbal expressions of caregivers about their child, it is possible to assess parental attitudes toward children.

The study's objectives are as follows: (1) to create a German version of the FMSS for infants (Infant Five Minute Speech Sample, IFMSS) and to test whether parental ratings are influenced by demographic characteristics; (2) to examine whether higher scores on the IFMSS dimension "critical comments" are associated with elevated maternal depressive symptoms; (3) to examine whether IFMSS categories are more strongly influenced by child-related strain than by depressive symptoms; (4) to clarify whether social support can buffer against the effects of depressive symptoms and child-related strain on emotional climate.

Socially and/or economically disadvantaged 150 mothers living in disadvantaged neighborhoods in Bremen, Germany, participated in the first wave of the Bremen Initiative to Foster Early Childhood Development (BRISE) and were asked to talk about their infants and their relationship with the infants for five minutes at three months postpartum to measure emotional climate. After excluding mothers who did not provide consent for recording, submitted non-German audio files, spoke for less than four minutes, or dropped out prior to the scheduled appointment, 90 speech samples were coded. The IFMSS manual included the following aspects: initial statement (IS), the relationship with the infant (REL), warmth (WAR), positive comments (PC), and critical comments (CC). Maternal depressive symptoms, child-related strains due to (a) infant sleep, (b) crying behavior, (c) breastfeeding, and perceived informal social support from family, friends and relatives were measured with questionnaires at the same measurement point.

The codings of the IFMSS showed adequate inter-rater reliabilities for all categories. The Bayesian analysis indicated that the demographic variables of the participants, such as maternal education, migration background, age, and parity, did not affect the IFMSS ratings. Thus, this suggests that the German IFMSS is an objective and test-fair instrument. Consistent with previous studies, mothers with higher levels of depressive symptoms made more critical comments about their infants. However, the critical comments were more strongly influenced by child-related strains than by depressive symptoms. Finally, social support buffered the negative effects of child-related strains and depressive symptoms on emotional climate.

Results suggest that the German IFMSS can be reliably used in early infancy and that infant-related strains play an important role in the mother-infant emotional climate during this period. Further research on speech samples in different languages with diverse samples is needed.

P2-B-250 - Parents' use of multimodal cues to initiate joint attention with infants

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Details

Parent-initiated joint attention involves parents making attentional bids to capture their infants' attention, with successful bids resulting in mutual attention to an object of interest (Mundy & Gomes, 1998). In recent research (Gabouer et al., 2020), we found that parents of both normal-hearing and hearing-impaired toddlers produced behaviors that exploited a range of sensory modalities to capture their children's attention. In the current study, we extend this systematic approach to document interactions in parent-infant dyads in which the children are all typically developing and nearer to the age at which joint attention abilities first emerge. Previous research (e.g., Depowski et al., 2015; Suarez-Rivera et al., 2019) has shown that multimodal cuing by parents helps infants and young children sustain attention. However, it remains unclear whether and how parents incorporate multimodal cues to initiate joint attention with their children. In the current study, we tracked moment-to-moment behavior during parent-infant interactions to document parents' use of multiple sensory modalities to establish joint attention with their infants. We then identified which cues or combination of cues were associated with successful parental bids for joint attention, and which with failed bids (Table 1). Results from a total of 38 parent-infant (N_{child} = 24 female; $M_{\text{child age}}$ = 12.77 months, SD = 0.32) dyads showed that parents most often engaged their infants in joint attention using multiple sensory modalities (Table 2). Critically, we found that the number of sensory cues in parents' attentional bids significantly predicted bid success. These findings underscore the multimodal nature of parent-infant interaction and contribute to our understanding of the myriad ways in which parents achieve joint attention with their children.

P2-B-251 - Testing infants' word comprehension online: Carrier phrase matters

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Details

Online research provides various potential benefits for infant studies, such as accessibility, transparency and efficiency. The current study explores the possibility of conducting eye-tracking research with infants online. Within a laboratory setting, a frequently employed paradigm for evaluating participants' word comprehension is the Looking-While-Listening procedure (LWL, Fernald et al., 2006). In this procedure, target nouns are typically embedded in a carrier phrase, such as "Look at the [target]!". Previous in-lab research has revealed that presenting words in a sentence frame, as opposed to in isolation, facilitates infants' word processing (Fernald & Hurtado, 2006). The goal of the current study is to investigate whether carrier phrase affects infants' accuracy in an online LWL-task. We compared infants' looking accuracy in three conditions: target embedded in a sentence frame (sentence

condition); target preceded by an article (article condition) and target presented in isolation (word condition).
Caregivers and their infants aged 1;0-2;0 years were recruited through Lookit: a browser-based platform that uses caregivers' webcam to record children's eye-movements (Scott & Schulz, 2017). Our final sample consisted of 46 infants (27 females, *Mage* = 1;6, *SDage* = 0;3). All children resided in the United States. The stimuli consisted of six frequently occurring, age-appropriate nouns. Using a within-subject design, participants were tested on their recognition of all six nouns in all three conditions (6 trials x 3 conditions = 18 trials in total).
With a grand mean of 56.4% (SD = 5.7%), infants' accuracy was significantly greater than chance level, p<.001. To test whether condition affected accuracy, we created a linear mixed-effects model (accuracy ~ condition + age + condition*age + (1|participant) + (1|item)). The results of this model reveal that accuracy in the sentence condition was significantly higher than in the word condition, p = .03, and article condition, p = .04 (Figure 1). Age also emerged as a significant predictor, with accuracy increasing 1.3% per month. In addition, a significant interaction effect between age and condition was found, p = .02 (Figure 2). To follow up on this interaction effect, we divided infants into 4 equal age ranges and found that younger infants, aged 1;6 years and below, did not perform above chance, p > .5.
Based on these findings, we conclude that the way in which target words are embedded matters for online LWL-studies. Infants achieve higher accuracy when the target word is embedded in a sentence frame, compared to when it is preceded by an article or presented in isolation. Moreover, our results demonstrate that the LWL-paradigm can successfully be implemented online, albeit with older infants. With infants between 1;0-1;6 years not performing above chance, the lower bound of the testable age range seems to be higher for online LWL-experiments than for in-lab experiments (e.g. Bergelson & Swingley, 2012). Thus, future studies using an online LWL-procedure will benefit from embedding the target word in a sentence frame and testing infants older than 1;6 years.

P2-B-252 - Using music enrichment programs to promote early language development from a social learning perspective: The role of parental responsiveness

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Details

The first two years of life are critical for language development. Numerous studies indicate that actively participating in music creates a neural processing advantage in brain regions that support language development. Nevertheless, shared social characteristics between music and language may also play a role in explaining the benefits of music engagement during infancy on language development. Despite several observational studies that suggest a positive association between active music engagement and language development, only three studies were found that assessed the causal effects of music enrichment programs on attributes of infant language development (Gerry et al., 2012; Nicholson et al., 2008; Smith et al., 2023). These studies provide emerging causal evidence that music enrichment programs represent a valuable tool for enhancing language development during infancy. However, the mechanism through which music enrichment classes impact early language development is yet to be investigated. In this review, we posit that music enrichment programs indirectly benefit language development through enhanced parental responsiveness, an aspect of high-quality parent-infant

interactions. The aims of this narrative review are to 1) summarize the current research regarding parent-child music enrichment classes and early language development and 2) provide evidence demonstrating that parental responsiveness explains in part the association between music engagement during infancy and early language development.

Language interactions are most powerful when they are contingent on an infant's cues and reference the infant's activity or focus (Gilkerson & Richards, 2009). As such, parental responsiveness is one attribute of high-quality social interactions that is associated with facilitating language development (Tamis LeMonda et al., 2014). Several studies have evaluated the effects of music enrichment on infant regulation, attention, and responsiveness – critical attributes that support the ongoing reciprocal loop of parent-infant social interaction (Gerry et al., 2012; Nicholson et al., 2008; Nicholson et al., 2010; Standley et al., 2011). Additionally, in numerous studies of children with specific risk factors, the Sing & Grow music program improved parent-child interactions, as well as parent confidence, sensitivity, and mental health (Abad & Williams, 2007; Nicholson et al., 2008; Nicholson et al., 2010; Stewart, 2021). Research has shown that parent-child musical interactions (e.g., singing) captures infants' attention, synchronizes the dyad's arousal, and reduces infant distress more so than non-musical interactions (de l'Etoile, 2006; Nakata & Trehub, 2004; Shenfield et al., 2003). While singing to infants, caregivers present more positive facial affect and use more physical gestures and movement which enhance the social exchange (Cirelli et al., 2018; Trehub et al., 2016). Parents have also reported integrating new musical repertoire into everyday life after participating in music enrichment programs (Mackenzie & Hamlett, 2005).

Music enrichment programs are touted as providing broad developmental benefits to infants; however, the specific mechanisms supporting these benefits are not well understood. Regarding language development, music enrichment programs may represent an important context for enhanced parental responsiveness with a direct impact on optimizing the language environment. Future mechanistic research should be conducted to rigorously investigate how music enrichment impacts parent responsivity and the link to language development.

P2-B-253 - Early word recognition in infancy predict vocabulary in toddlerhood; how eye-tracking captures early variability in vocabulary

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Details

Early word recognition (i.e. early receptive vocabulary) has been posited to be an important foundation for future vocabulary development (e.g. Bergelson, 2020). However, it is still unclear how to best capture early word recognition. Even though parental report is commonly used, it is unclear whether parents are good at estimating this early ability (Bergelson & Swingley, 2012; Feldman et al, 2005). An alternative strategy is to observe the infants directly, and two paradigms seem particularly promising. In the preferential looking paradigm, infants are presented with two objects and are tasked to find a target (e.g. "look at the pacifier"). In the mismatch paradigm, infants are presented congruous and incongruous matches between labels and object (e.g. seeing a teddy bear, but hearing "look, a duck!"),

measuring whether infants detect a mismatch. Using these tasks, previous research has demonstrated that infants already at 6-9 months of age recognize familiar words (Bergelson & Swingley, 2012; Parise and Csibra, 2012). However, no study has investigated whether performance within these tasks are stable during infancy, nor how it relates to other measurements of vocabulary longitudinally. Thus, it is unclear if these tasks capture meaningful variability in early word recognition with important developmental effects. To breach this gap, we collected data on 70 participants at 10, 11.5, 18 and 24 months of age, using the preferential looking- and mismatch paradigm, as well as the Communicative Development Inventories (CDI). Using zero- order correlations, our result show that performance within the preferential looking paradigm is quite stable between 10 and 18 months of age (r = .50, p<.001), but performance within the mismatch paradigm is not stable yet. Further, we show that both the preferential looking- and mismatch paradigm is significantly correlated to both concurrent and later receptive and expressive vocabulary (as measured by the CDI). We note that the mismatch paradigm showed an unexpected relation to CDI, such that infants' ability to detect matching stimuli was correlated with greater receptive and expressive vocabulary, see table 1. This warrants further investigation of the mismatch paradigm. Further still, these associations hold when controlling for a number of socio-demographic variables important for vocabulary development, such as SES (Piot et al, 2022). Together, the results indicate that both the preferential looking- and mismatch paradigm capture some individual variance important for vocabulary development. In turn, it suggest that at least the preferential looking paradigm could be a good complement to parental reports when investigating early vocabulary in infants.

P2-B-254 - Studying language environments of infants in Spanish-speaking low-income households in the U.S.: A feasibility study

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Details

Background

In the United States, Hispanics constitute the fastest-growing minority group. By 2050, they are projected to make up about 30% of the population, but they currently represent only 3% of the participant research pool (Arana-Chicas et. al, 2022). Hispanic children disproportionately live in high-poverty areas with limited resources, putting them at risk for language delays which predict mental health, academic performance, and high school completion rates. Ensuring adequate Hispanic participation in research studies is a crucial step in addressing the disparities these communities face.

Objective

The current study aims to examine the feasibility of collecting home language recordings using the LENA digital language recorders as part of a parenting support program for low-income Hispanic families.

Methods

Play with Me is a community-based, intervention program serving parents with children ages 0-3 years. This 12-week program's objective is to guide playful learning experiences to advance strong foundations for school readiness. Data was collected at four sites, in spring and summer 2023. Language samples were collected using digital language recorders in week 2 or 3 (Time 1), and again in week 11 or 12 (Time 2). At each time point, families were to complete one full day (16 hours) of recording using the LENA Digital Language Recorders. The following variables were automatically extracted by LENA software for analysis: Adult Word Count (AWC), Child Vocalization Count (CVC), and Conversational Turn Count (CTC).

Results

During the period of this feasibility study, 78 children were enrolled in Play With Me, of which 31 consented to participate in LENA data collection, with 29 providing usable data at Time 1. Of these, 15 provided usable data in Time 2. Usable data was defined as recordings with a duration exceeding 10 hours.

Discussion

This pilot feasibility study highlighted difficulties with data collection. First, a low percentage of families consented into the study. Families expressed worries about being recorded in their homes, concerns about the safety of the device, and reported that since their infants were pre-verbal they would not contribute meaningfully to the research. Of the families that consented, only half of the families contributed usable data at both time points.

Strategies were implemented to enhance the comfort of families in our research and to increase enrollment rates. We enhanced communication with parents by offering post-program lunches where research staff were available to answer questions about the research study. We emphasized the value of having pre-verbal infants in our study. We also had regular follow-ups with participants which ensured sustained engagement and retention. The return of recorders with usable data was a challenge, highlighting a need for clearer instructions and follow-up support for families.

Successful implementation of data collection using LENA digital language recorders in Spanish-speaking Hispanic communities, with low incomes and low formal education—characteristics of the families served by the program—will generate key insights into the language environment in Hispanic households. This information can then be used to create culturally, and linguistically appropriate intervention programs aimed at reducing the disparities we see in the community.

P2-B-255 - Participation in an online music program can lower stress in mothers of toddlers with cochlear implants (CIs) after CI activation

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Details

INTRODUCTION: Numerous authors have highlighted the relationship between children's language fragilities and parental stress (Lisa et al., 2019). Mothers of children with cochlear implants (CIs) could experience distress after the communication of the diagnosis (Majorano et al., 2019) and maintain high levels of stress even afterwards (Continisio et al., 2023), due to their children's communication difficulties in daily interactions. Researchers have addressed that active participation in parent-child music classes could promote well-being of families of children with typical and atypical development (Lense et al., 2020). Moreover, evidence suggests that music trainings are effective rehabilitation tools for children with CIs (Ab Shukor et al., 2023). To the best of our knowledge, no study has investigated the benefits of a music program on mothers of children with CIs. The present study explores if an online music program can support mother-child with CI's communication and sustain mothers' parenting-related stress in the first year after children's CI activation. We present data relative to 6 months after CI activation. METHOD: Ten Italian toddlers with CIs (*M*age= 13.9 months; SD=7.6 months) with their mothers (*M*age= 35.8 years; SD=3.4) (CIs-T) participated in a 12-week online music program starting at 3 months after CI activation. The proposed stimuli involve rhythm, pitch and melodies. Activities include listening, movement, playing instruments and turn taking. The CIs-T group is compared to an age-matched group (CIs-C) of ten Italian toddlers with CIs (*M*age=15.2 months; SD=4.4) and their mothers (*M*age=33.9 years; SD=5.5), who did not participate in the program. We administered mothers the short form of the Parenting-Stress Index (PSI; Abidin, 1990) and the short form of Words and Gestures of the Mac Arthur-Bates Communicative Development Inventories (MB-CDI; Fenson et al., 2007). Participants were tested before (T1) and after (T2) the music program. RESULTS: Mothers' mean levels in the "Total Stress" scale decreased for both groups, but a steeper slope in the CIs-T group than in the controls emerged. The "Parental Distress" dimension increased for the CIs-C group and decreased for the CIs-T group. The "Difficult Child" subscale increased for the CIs-T group and decreased for the CIs-C group. Small decreases for the CIs-C group occur in the "Parent-Child Difficult Interaction" subscale, while we observe no change for the CIs-T group. A repeated measures ANOVA showed non-significant differences between the two groups at T2. Moderate correlations ranging from r=-.46 to r=-.56 ($p<.05$) were found between all PSI scores (both for "Total Stress" scale and for "Parental Distress", "Parent-Child Difficult Interaction" and "Difficult Child" subscales) at T1 and at T2 and children's MB-CDI production scores, both at T1 and at T2. DISCUSSION: Preliminary results suggest that a 12-week interactive online music program could help reduce the stress in mothers of toddlers with CIs at 6 months after CI activation, specifically with respect to parenting-related difficulties. Moreover, the negative associations found between parental stress and children's vocabulary are consistent with the available evidence. A larger sample and an additional follow-up may clarify the specific contribution of the music program on mothers' well-being.

P2-B-256 - How sampling affects lexical analysis of bilingual infant-directed speech in daylong audio recordings: A pilot study

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Details

Exploring the characteristics of infant-directed speech (IDS) is crucial to understanding infant language development (Pan et al., 2005; Ramirez-Esparza et al., 2014) but despite rising multilingualism globally and in Canada, studies mostly focus on monolingual experiences, leaving bilingual infants underserved (StatCan, 2017). Monolingual studies show that repetition is most useful in the 1st year of life and word types in the 2nd year (Newman et al., 2016; Rowe 2012). However, bilingual infants acquire each language at different rates (Hoff et al., 2012), so caregivers may adapt the complexity of their IDS in each language meaning that this repetition/word-types developmental pattern may play out differently for bilingual infants. In bilingual homes, there is a complex interplay between the different speakers who provide input, the language(s) they use, and infants' evolving input needs in each language. Unlike brief, task-constrained methods such as lab- or home-visits, in-home daylong recordings capture such complexity, such as the Montreal Bilingual Infant (MBI) corpus (Orena et al., 2020). But while systems such as LENA™ calculates total adult input from recordings, it does not tag different languages, IDS, or analyze lexical diversity (LD). Manual transcription, a resource-intensive process, is needed to analyze the lexical properties of bilingual IDS in such corpora. Thus, there is a pressing need to devise efficient methods for extracting samples in ways that meaningfully represent the heterogenous character of bilingual IDS. Additionally, there are multiple possible LD indices: (1) type-toke-ratio (TTR)—a common method but sensitive to corpus length—and (2) Guiraud's Index (GI)—a less common but more stable measure (Van Hout & Vermeer, 2007). With these unresolved issues in mind, we have designed a pilot study (https://osf.io/t94zx/) to find optimal sampling rates and a suitable LD measure for bilingual IDS based on a subset (n = 4) of families from the MBI corpus. Recordings were collected at 10 and 18 months in the homes of families raising French-English bilinguals in Montreal, Canada. Recordings were split into 30-s segments and 50% of non-silent segments tagged for language (French, English), speaker (mom, dad), and listener (infant, multiple; Orena et al., 2020). We will isolate those segments containing dyadic interactions and randomly sample 5% of segments where Mom speaks French at 10 months. We will then randomly resample 10%, 15%, & 20% of such segments. The audio will be transcribed, and LD measures computed. The process will be repeated for each speaker/language/age combination. We have formulated two hypotheses: **(H1)** Measures of LD produced by caregivers will differ across corpus sampling rates, interacting with language, speaker type, and infant age. **(H2)** GI will prove more stable across sampling rates versus TTR. Our findings will aid in establishing efficient sampling rates for larger bilingual infant corpora and determine an appropriate LD measure for bilingual IDS. In turn, this will open the door for a more holistic understanding of how language input evolves in its complexity to support bilingual infants in learning two languages simultaneously.

P2-B-257 - An Introduction to The NIH Baby Toolbox: A new standardized development assessment for infants and toddlers

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Details

Tracking developmental change in the first few years of life is essential as infancy and early childhood reflect a critical period for physical, mental, and social development. Assessment in pediatric populations is necessary for monitoring health outcomes, differentiating typical from atypical development and allowing for earlier interventions. In this presentation, we introduce a brand-new assessment for 1-42 months-olds The NIH Infant and Toddler Toolbox, or "Baby Toolbox."

The Baby Toolbox is a tablet-based assessment battery normed in both English and Spanish. It includes brief measures across key developmental domains determined and guided by experts to be most critical in early development, including memory, learning, executive functioning, language, numeracy, social functioning, emotional and behavioral regulation, and motor function. Measures were derived from either established, validated instruments or standardized versions of evidence-based paradigms accepted in developmental, cognitive, social, or behavioral neuroscience fields. Measures include a variety of assessment approaches, such as gaze-tracking and performance-based tasks on the iPad and with manipulatives, examiner observation, and parent report questionnaires. This presentation will describe the domain structure of the Baby Toolbox, and review the primary measures included as part of each domain and subdomain (See Table 1). The presentation will also outline how the selection of domains and measures was informed by an expert survey of over 450 clinicians and developmental researchers, as well as a scoping review of over 37,000 articles in the developmental literature.

We will outline the unique features of the Baby Toolbox, including automatic tablet-based gaze-tracking, video observation with playback, computer adaptive testing (CAT), and automated scoring. We will present data on the results of a number of preliminary studies including the success of a norming study which tested 2550 infants in English and Spanish at 16 sites across the US. This includes our use of a Train-the-Trainer model and the certification success of examiners trained directly by our staff (N=24, 92% scoring accuracy) and examiners trained by trainees (N=66, 92% scoring accuracy). We will also present reliability evidence for our gaze-tracking technology (initial agreement between Baby Toolbox gaze algorithms and expert-hand coding on a sample of four participants with 10,184 unique samples found agreement was high: Cramer's V = 0.40, $p<.001$). Results for calibration success across infants of different ages, races, and eye-colors will also be presented (analyses ongoing, expected completed by February 2024).

The NIH Baby Toolbox will be available to the developmental community in late 2024, advancing the quality and standardization of developmental assessment and providing a sustainable and standard measurement tool for diverse users across the developmental research and clinical communities. We are enthusiastic that it will be a powerful asset to those working to understand developmental processes, diseases, and delays, and become a foundational tool in efforts to support healthier development in infancy and toddlerhood.

P2-B-258 - Monitoring ECD across ages and tools: Equating scores from the GSED and the ECDI2030

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Details

Introduction: Goal 4.2.1 of the Sustainable Developmental Goals originally aspired to measure ECD for children from birth to five. Methodological and logistical challenges with measurement for the youngest children internationally led to revision of this indicator to focus on children 24-59 months using the 20-question Early Childhood Development Index 2030 (ECDI2030).

The World Health Organization, in conjunction with a global academic working group, recently released the Global Scales for Early Development (GSED), a tool designed to measure development of children 0-35 months using the Developmental (D)-score, a Rasch-model based scale. With ample evidence of the importance of the earliest years of children's lives, there is a desire to extend monitoring of SDG 4.2.1 to children under the age of two. We hypothesize that it is feasible to link scores across GSED and ECDI2030 to create a harmonized score that would expand monitoring of SDG 4.2.1 to include of children under the age of two.

Methods: GSED and ECDI2030 data were collected in four countries on 4,629 children to assess the possibility of linking these two scores. Nine of 20 ECDI2030 items appear in the 139 GSED Short Form (SF) items. Given this, our analysis utilizes both a common-item and common-person equating design. The D-score Rasch model was applied to the data, aligning item parameters of the common items with the D-score model's calibration. Next, only the best fitting links among the shared items were retained after inspection. The remaining items underwent assessment for item fit (infit/outfit < 1.2). Finally, validation involved comparing the final D-scores derived from the ECDI2030 items with the GSED D-scores to validate the calibration.

Results: We find adequate properties for the linking of these two assessments. In terms of calculating GSED D-scores from ECDI2030 items, of the nine shared items, seven demonstrated reasonable infit/outfit for the Rasch model used in the calculation of D-scores. Two ECDI2030 items were dropped in the process due to inconsistent age gradients. D-scores generated from GSED data and ECDI2030 data show similar patterns (Figure 2a) allowing us to convert ECDI2030 score to D-scores.

D-scores calculated from ECDI2030 show markedly larger standard errors of measurement (Figure 2b) than those calculated from GSED due to the larger number of items on the GSED. This results in a larger age gradient on GSED D-scores. Nevertheless, partial correlations between GSED D-scores and vertically scaled ECDI2030 D-scores controlling for years of age were about .6 across age groups.

Conclusion: Our results indicate that population-level inferences similar to those generated by ECDI2030 can be produced with the GSED. Our findings are the first step in harmonizing the monitoring of ECD at population level across tools. Future work will build on these results to develop a common methodology to classify the proportion of children that are developmentally on track based on ongoing GSED research focusing on a diverse group of children developing with minimal constraints to develop D-score growth charts analogous to growth standards used to monitor stunting.

P2-B-259 - Deviations from normative neonatal connectomes correlate with prenatal exposures and toddler behavior

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Details

The human connectome—a whole-brain connectivity map—undergoes rapid changes during the perinatal period. Yet, a normative model of the early connectome does not exist. Brain age prediction is a novel approach to normative modeling. This approach consists of two steps. First, a machine learning model is trained to predict an individual's age using neuroimaging data. Second, the difference between the individual's predicted and chronological age—or brain age gap (BAG)—is calculated. Thus, BAG represents the deviation from normative brain measures at any particular age. Other participant characteristics (e.g., exposures, behavior) can be associated with BAGs to investigate their impact on normative development. Here, we calculated BAGs based on resting-state fMRI and DTI for 437 infants from the Developing Human Connectome Project using connectome-based predictive modeling (CPM) with 10-fold cross-validation. Using structural connectomes, we significantly predicted PMA (r=0.73, p=7.39e-74; mean absolute error (MAE)=0.92 weeks). Similarly, using functional connectomes, we significantly predicted PMA (r=0.42, p=3.57e-20; MAE=1.25). Structural brain ages significantly correlated with functional brain ages (r=0.36, p=4.11e-15), suggesting a moderate structural and functional development coupling. We identified ten prenatal and early postnatal measures across four common exposure types: maternal mental health (postnatal depression, lifetime psychiatry history), maternal physical health (age, BMI, high blood pressure, gestational diabetes), maternal demographics (age, education), and maternal substance use (smoking, alcohol, recreational drug use). Maternal age positively associated (r=0.13, p=0.0060), and recreational drugs use negatively associated with structural BAG (t-test: t=-2.87, p=0.0043, df=434), such that younger mothers and those that report substance use during pregnancy had infants with younger looking structural connectomes. Postnatal depression was positively associated (t=2.11, p=0.036, df=374), such that mothers with depression had infants with older-looking functional connectomes. Gestational diabetes was negatively associated with functional BAGs (t=-2.11, p=0.038, df=435), such that mothers with gestational diabetes had infants with younger-looking functional connectomes. Cognitive and behavioral assessments of infants at 18 months were performed, including the Bayley Scales of Infant and Toddler Development (BSID), the Child Behavior Checklist (CBCL), and the Early Childhood Behavior Questionnaire (ECBQ). Structural BAGs positively correlated with BSID cognitive (r=0.14, p=0.0077), CBCL externalizing problems (r=0.13, p=0.014) and total problems (r=0.12, p=0.024), and negatively correlated with ECBQ effort control (r=-0.16, p=0.0025). These results indicate that the older structural connectomes at birth associated with better cognitive function, worse emotion regulation, and worse externalizing problems. Functional BAGs positively correlated with ECBQ surgency (r=0.14, p=0.0089), suggesting that older functional connectomes at birth associate with better emotional reactivity. Overall, we established normative models of connectome development in neonates and highlighted that deviations associate with early-life maternal exposures and later behavior.

P2-B-260 - Parenting beliefs about attunement are related to responsive parenting behaviours

ICIS 2024 Abstract Book

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Details

Researchers, practitioners, and parents usually expect parenting beliefs to influence parenting behaviours and thereby influence child outcomes, but evidence of relations between parenting beliefs and behaviours is weak, especially for positive parenting beliefs and behaviours. The discrepancy between the expectation that parenting beliefs and behaviours are related and the evidence supporting that claim points to three methodological problems: the influence of social desirability on self-report measures; low variability in parenting beliefs, particularly positive beliefs; and the need for clearer, more conceptually grounded predictions about the potential correspondences between beliefs and behaviours.

The Baby Care Questionnaire (BCQ) describes and evaluates two beliefs about how to care for infants (Winstanley & Gattis, 2013). *Attunement* refers to beliefs about the importance of reading and responding to infant cues to inner states such as hunger, sleep, and distress. *Structure* refers to beliefs about the importance of regularity and routines, such as having predictable times for feeding and sleeping. We compared parenting beliefs about attunement and structure using the BCQ with observed parenting behaviours during semi-naturalistic play interactions between parents and infants. We distinguished between responsive parenting behaviours (maintaining infant attention) and demanding parenting behaviours (introducing or redirecting infant attention) and examined their relations with attunement and structure.

Hypotheses

Because attunement highlights the value of attending and responding to children's cues, we predicted that attunement beliefs should correspond to responsive parenting behaviour, as indexed by maintaining attention during parent-infant interactions. Because structure concerns the organisation and control of children's environments, we predicted that structure beliefs should correspond to parenting behaviours that place demands on infants, as indexed by introducing and redirecting attention during parent-infant interactions.

Study Population

Thirty-two mothers living in the UK participated in the study together with their infants, who ranged in age from 3.5 to 18 months (mean age 11.5 months). Infants were singleton births, had not undergone surgery, and were born full term. Half of the infants were first-born children. Nearly all participating mothers (87%) had a university degree.

Methods

Parent-infant dyads completed 10-minute semi-naturalistic play sessions in a child-friendly room at the university. The room contained a play mat, a cushion, and three baskets with age-appropriate baby toys, as well as wall-mounted recording equipment. Parents completed the BCQ on a computer in a different room after the play session had finished.

Trained researchers coded parent and infant behaviours from recordings of the interactions. Researchers followed established coding schemes to identify all attention-directing events (Bornstein et al., 2001, 1991; Cote & Bornstein, 2000; Gattis et al., 2020). In a separate coding phase, researchers categorised each attention-directing event as either maintaining, introducing, or redirecting attention based on the child's focus of attention immediately before the event (Landry et al., 1996).

Results

We examined correlations between parenting beliefs and behaviours to evaluate our hypotheses. Attunement was positively related to maintaining attention (r=.29) and negatively related to introducing (r= −.34). Structure was weakly related to introducing (r= −.11) and redirecting attention to the mother (r=.11).

P2-B-261 - Characterising infant neurodevelopment in diverse settings using functional change point analysis

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Details

Background: The period from conception to two years of age is particularly crucial for shaping neurodevelopment (Mattei & Pietrobelli, 2019). Habituation and novelty detection (HaND) provides the

foundation for the processes of learning; methods that accurately measure these processes provide valuable insight into brain development (Sicard-Cras et al., 2022). The Brain Imaging for Global Health (BRIGHT) project used a functional near-infrared spectroscopy (fNIRS) HaND paradigm to investigate brain responses via changes in the amplitude of hemodynamic responses evoked by spoken auditory stimuli in two longitudinal cohorts, in the UK (N=60) and The Gambia (N=204) (Lloyd-Fox et al., 2019). Here we present a novel approach for the analysis of the HaND paradigm – functional change point analysis (fPCA) (Aue et al., 2018; Horváth & Kokoszka, 2012, Chapters 6 & 16) – applied to fNIRS data for the first time to permit the characterisation of infant habituation and novelty responses.

Methods: Functional change point analysis (fCPA) is a method for time series analysis developed within the branch of mathematical statistics known as functional data analysis (FDA). Each function in FDA is viewed as representative of continuously changing underlying smooth phenomena, permitting the study of both the magnitude and shape of the data (Ramsay & Silverman, 2005). fCPA further exploits these characteristics to determine points of significant change in properties of the functional representations, the property in this instance being the mean function as representative of the haemodynamic response.

Results: We demonstrate the use of fCPA to capture significant points of change in the evoked hemodynamic responses as a result of habituation (Figures 1 & 2). We contrast results which are derived from comparing (i) the timing of habituation and (ii) the extent of habituation for individuals, within 3 distinct timepoints at 5-, 8- and 12mo, for both the UK and Gambia cohort. These are indicated, respectively, by (i) instances of structural change in haemodynamic responses given by the timing of change points and (ii) magnitude of the structural changes in haemodynamic functions according to area-under-the-curve (AUC) and corresponding volumetric calculations of mean responses between change points (Figure 2). In addition to determining the presence of a habituation or novelty response, as is the case with established analyses, this approach allows us to characterise the timing and form of such responses which may permit discrimination between the neurodevelopmental trajectories for individuals or groups.

Discussion: fCPA analyses may permit discrimination between different patterns of habituation and novelty detection, serving as early markers of neurodevelopment. We also discuss future research avenues that may be of interest to the wider field of infant studies, including the exploration of relationships between these measures and (i) other contemporary measures of development, (ii) later developmental outcomes, and (iii) risk and resilience factors for early childhood development.

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P2-B-262 - Validation of body posture as a novel measure of emotion in infancy and early childhood

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Details

A recent body of work has employed motion depth sensor imaging (the Microsoft Kinect) to measure infants' (Hepach et al., 2022), and young children's emotional expression (Gerdemann, McAuliffe, et al., 2022; Gerdemann, Tippmann, et al., 2022). These studies have found that prosocial actions, such as helping others complete their goals result in an upright upper body posture (Hepach et al., 2022). In contrast, failing to help others, and, to some extent, disadvantaging peers, results in a lowered upper body posture in childhood (Gerdemann, McAuliffe, et al., 2022; Gerdemann, Tippmann, et al., 2022). An underlying assumption of these studies is that expressed postural elevation as measured by the Kinect reflects emotion valence. This assumption has been supported by studies with adults, in which they are asked to pose emotional expressions (von Suchodoletz & Hepach, 2021).

The goal of the present study was primarily to validate automatically recorded measures of posture as measures of *children's* emotion *valence*. We also aimed to assess, for the first time, the degree to which changes in upright posture reflect emotional arousal as opposed to valence. To this end, we aggregated data from 6 studies, and asked two independent coders to rate children's (N = 466, M_{age} = 5.08; range: 2 years and 5 months to 6 years 2 months; 220 girls) emotional response. Data was presented to coders in the form of video stills, which were recorded by the Kinect camera after emotion eliciting events, such as after failing or succeeding to help (Gerdemann, Tippmann, et al., 2022; Hepach et al., 2022). Coders, who were blind to conditions, used self-assessment mannequins (Bradley & Lang, 1994) to rate children's emotion valence and arousal on a 5-point scale. As preregistered (https://aspredicted.org/9ws52.pdf), we examined the relation between valence, and arousal with three different body posture measures: the vertical change (from baseline) in the chest center data point; the change in the hip center data point; and the change in chest expansion, which was calculated by subtracting the change in hip height from the change in chest height (Figure 1A).

As predicted emotion valence was positively associated with children's change in chest height and chest expansion (Figure 1B). Thus the more upright children's chest center data point on the test trials compared to baseline and compared to their hip height, the more positive children's overall emotion valence was rated. Children's change in hip height alone was not associated with any of the measures included in the model (Figure 1B). There was also an association between the change in chest expansion with emotion arousal and age. However, these effects might be due to older children participating in some of the studies which induced more intense negative emotions, similar to shame or guilt (Gerdemann, Tippmann, et al., 2022).

In conclusion, the present study provides a strong empirical foundation to conduct studies of children's spontaneous emotional expression using a novel, automated, and efficient tool.

P2-C-263 - Early trajectories of communication skills in autism spectrum disorder: Parental reports and microanalysis data

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Details

Objective: Autism Spectrum Disorder (ASD) is one of the most prevalent neurodevelopmental disorders thatcan cause significant social, communication and behavioral challenges (APA, 2013). Early detection of ASD is crucial for early intervention or even prevention of its full manifestation (Dawson,

2008; Zwaigenbaum et al., 2013). Studies using different methods reveal profound deficits in prelinguistic communication skills (Charman et al., 1997; Franchini et al., 2019; Ohta et al., 1987; Ozonoff et al., 2010; Stone et al., 1994; Zwaigenbaum et al., 2013). The present study aims to further investigate the development of communication skills in ASD by combining parental reports on early ASD symptoms with microanalysis of video-recorded interactions between toddlers diagnosed with the disorder and their mothers. Although parental reports may be subjected to recall biases, it is also possible that parents recall more salient behaviors of the disorder.

Methodology: Participants were 15 ASD children (mean CA: 54.1 months) and 15 typically developing children (mean CA: 17.1 months). All children were at the single-word stage and were matched for visuospatial, fine motor, and language abilities. Five visits were carried out during a month. In the first visit the *Mullen Scales of Early Learning* (Mullen, 1995) was administered, while mothers completed the *Modified Checklist for Autism in Toddlers* (M-CHAT) (Robins et al., 1999) and a questionnaire on demographic information and the child's medical background, which also asked mothers to report the age when critical communication skills appeared for the first time. In the next four sessions video-recordings of mother-child interactions in a structured naturalistic setting were obtained. The onset and offset of each behavior (gaze, vocal/verbal, gestures, actions to other or objects) for both partners was annotated.

Results: Parental reports revealed that infants later diagnosed with ASD not only did develop communication skills at a slower pace compared to typically developing infants but they also did not follow the typical developmental sequence i.e., smile and maternal recognition > word comprehension > pointing > question/order comprehension > sharing. Rather, in the ASD group maternal recognition developed later than smile and pointing later than question/order comprehension and sharing. At the study period ASD toddlers demonstrated significantly less joint attention initiations and less functional play than typically developing children. Joint attention initiations were significantly positively correlated with functional play. Also, both joint attention initiations and functional play were directly negatively correlated with the age that smile started, while joint attention initiations were also negatively correlated with the age that infants begun to understand words and questions/orders.

Conclusion: Combined data from parental reports and microanalysis of video-recorded mother-child interactions confirmed that in ASD the development of communication skills is both delayed and deviant, while delays observed by parents during the first year of life (even the first three months) may predict joint attention initiations and functional play in toddlerhood. These findings imply that parental perceptions about their children's early communication skills along with direct behavior observations may be utilized for early diagnosis and treatment.

P2-C-264 - Characterization of early skill profiles across populations at varying genetic likelihoods for neurodevelopmental disorders in the first year of life

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Details

Background

Several domains of infant behavior have been identified as promising early markers of ASD features, including social communication delays, atypical attention, and motor deficits. Although research involving early predictors of ADHD features of infants is much scarcer, comparable profiles of social communication, attention, and motor skills, have been found among school-age children with ADHD and ASD (Geurts & Embrechts, 2008). Given that assessing early features of ASD and ADHD is fundamental to increasing impactful diagnoses early in life, this study examined social communication, attention, and motor profiles across 12-month-old infants at an elevated genetic likelihood for ASD (EL-ASD), ADHD (EL-ADHD) and low genetic likelihood for either disorder (LL).

Methods

Participants (n=107) were enrolled in a study of infant development. At 12 months, parents were asked to complete the First Year Inventory (FYI), the CSBS Caregiver Questionnaire (CSBS) and the Early Motor Questionnaire (EMQ). The FYI was scored according to instructions found in Stephens and Colleagues (2017) article resulting in three attention constructs: Responding to Social Attention (Response), Initiating Social Attention (Initiation), and Nonsocial Sensory Attention (Sensory).

Results

No differences were observed between participant groups in the speech composite ($F(2)=1.85$, $p=0.16$), or symbolic composite ($F(2)=0.32$, $p=0.73$) of the CSBS. EL-ADHD participants received higher scores on the social composite ($F(2)=4.34$, $p=0.02$) compared to EL-ASD participants ($p=0.03$). Differences between participant groups were not observed on gross ($F(2)=1.68$, $p=0.19$) and fine ($F(2)=0.23$, $p=0.79$) motor scores.

For FYI attention constructs, EL-ASD participants scored lower than LL participants ($p=.00$) in Response ($F(2)=6.39$, $p=0.00$), and Initiation ($F(2)=9.13$, $p=0.00$). EL-ASD participants also scored lower than EL-ADHD ($p=.00$) participants in Initiation. No significant differences between the groups were observed for Sensory ($F(2)=0.85$, $p=0.43$) attention.

Discussion

EL-ADHD infants scored higher than EL-ASD infants on the social composite of the CSBS, which captures behaviors such as eye-contact, getting the attention of caregivers, and gestures. EL-ASD infants also scored higher than LL infants in the Response attention construct. Similarly, EL-ASD infants scored higher than LL and EL-ADHD infants in the Initiation attention construct. Although these constructs are meant to measure attention, they also include aspects of social communication (i.e., responding to name, pointing). As social deficits are a core symptom of ASD, but not ADHD, these finding support diagnostic differences and suggest that these differences can occur as early as 12 months of age.

Results of this study did not find differences between EL-ADHD and LL infants on communication, motor, and attention skills. It is possible that at this early age, differences between EL-ADHD and LL infants' behavior have not appeared. Further, this study utilized parent report of skills and parents may experience difficulty reporting on certain internal experiences (i.e., Sensory) of their child or picking up on subtle differences in behavior. Particularly, parents with ADHD may experience more difficulties reporting on their child's behavior due to challenges with attending to the questionnaire.

P2-C-265 - Spatiotemporal parameters of gait in toddlers with ASD: a preliminary study

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Details

Despite not being included in the core symptoms of Autism Spectrum Disorders (ASD), limitations in motor performance are increasingly mentioned as one of the early symptoms of the disorder (Lim et al., 2017; West, 2019). These difficulties are pervasive among ASD children, with a prevalence as high as 87% (Bhat, 2020). Some developmental models point to motor disturbances as one of the early factors that could precipitate atypical developmental cascades resulting in the development of the social impairments that determine the core symptoms of autism (Cook, 2015). Among these, gait abnormalities have been reported in clinical descriptions (DSM 5; APA, 2013) and in a few research reports (Kindregan et al., 2015), which do not yet include a biomechanic analysis of gait in young children with little walking experience.

The aim of this preliminary study was to compare spatiotemporal parameters of gait in ASD and typically developing (TD) toddlers. For this purpose, we recruited 12 ASD and 8 TD boys aged between 18 and 30 months with approximately 11 months of walking experience. They were encouraged to walk back and forth in linear sequences in a laboratory equipped with a Vicon T160 motion capture system, which tracked the 3D trajectories of twenty-five retro-reflective spherical markers placed directly on the inferior limb and hips. For each participant, gait sequences were consensually selected by two trained clinicians. Using a previously developed algorithm, we extracted the following spatiotemporal features for each participant and each side (R and L): walking angle, walking speed, cadence (gait cycle/min), stride (mm), step length (mm), step width (mm), stride time (s), stance time (s), stance ratio (%), initial double support (s).

We applied nonparametric tests in order to assess differences in average gait parameters between ASD and TD groups. We also tested for differences between groups in intra-individual variability using coefficients of variation. We did not find significant differences when comparing average gait parameters between both groups. We did, however, find significantly higher intra-individual variability in the stride length, stance time, step width and speed of ASD children.

High intra-individual variability in these biomechanics parameters could be an indicator of an atypical maturation of gait abilities in ASD children in comparison with TD children with similar walking experience (Hadders-Algra, 2010). Because a slower maturation of walking ability could hinder the development of social communication and language skills (Cook, 2015; Walle & Campos, 2014), it is crucial to understand the developmental trajectory that characterises the influence of the former on the latter and whether early intervention could optimise this relationship.

P2-C-266 - Engaging priority populations with routine developmental screening in primary care settings using a web-based tool for toddlers

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Details

The Australian Early Development Census data indicates that around one in five children commence school with “developmental vulnerabilities”, and the rate is double in disadvantaged communities. Parental uptake of developmental screening during the toddler years is currently inadequate, despite early intervention providing the most promising avenue for improving child developmental outcomes. The aim of this study is to evaluate uptake of an innovative web-based tool (“Watch Me Grow”, WMG) for developmental checks in primary care settings. The WMG tool provides users with i) a dual screener (Learn The Signs Act Early + Quantitative Checklist for Autism in Toddlers), ii) for families who raise concerns, a secondary screener, and iii) feedback with anticipatory guidance and recommendations based on screening results. As part of a larger longitudinal cluster Randomised Controlled study, health care staff at participating General Practices invited families of toddlers aged between 16 to 35 months to participate in a study evaluating uptake of a web-based developmental screening tool (intervention) compared to current practice (service as usual). The participating General Practices were located across South Western Sydney, thus the study sample broadly represents a culturally diverse and socially disadvantaged priority population. Here, we report on a subset of data from families recruited onto the study intervention arm who have thus far completed a baseline developmental screen. Preliminary data from 200 families indicate that 52.8% of the sample were female, the primary language spoken at home was English (n= 9 languages other than English spoken at home), the majority of families were two parent households and received a minimum of high school education. Of the preliminary sample, 19.5% of toddlers were identified as showing risk of developmental delay on the secondary screener, with the primary concern relating to communication issues. This study contributes to the growing evidence base that online tools can aid completion of developmental screening of toddlers. Longer term sustainability of online developmental surveillance will be examined in the ongoing study using automated follow up reminders inviting families to complete the next age appropriate screen for three and four year olds.

P2-C-267 - Oxytocin-induced labor, neonatal outcomes, maternal bonding, and depressive symptoms in the 6 months postpartum

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Details

Background

The hormone oxytocin plays a role during labor. Compared to natural oxytocin, synthetic oxytocin administrated during birth is linked to adverse neonatal outcomes, maternal bonding difficulties, and postpartum depression. The current study investigated the association between oxytocin-induced labor, neonatal outcomes, maternal boning, and depressive symptoms at 6 months postpartum.

Methods

Participants included 1151 Swedish mother-infant dyads, all singletons with spontaneous vaginal delivery mode. In the control group (n = 620 mothers; 305 boys; mean age = 31.62 ± 4.48; mean BMI = 23.33 kg ± 3.85), no synthetic oxytocin was administrated. In the exposure group (n = 531 mothers (264 boys; mean age = 30.83 ± 4.40; mean BMI = 24.07 kg ± 4.57), the exposure window started 3 days prior to delivery. Outcome measures right after delivery included 5 min-Apgar score, referral to the neonatal intensive care unit (NICU), birth length, birth weight, and head circumference. At 6 months postpartum, maternal bonding was evaluated using the Postpartum Bonding Questionnaire. Depressive symptoms were assessed by the Edinburgh Postpartum Depression Scale (cutoff 12) at 6 weeks and 6 months postpartum.

Results

For neonatal outcomes, there was a significant difference in NICU referral (X^2 = 56.84, *df* = 1, *p* <.001) between the control and exposure groups. Results using independent samples test showed a significant difference in Apgar score ($t(1144) = 2.813$, $p = 0.005$), and head circumference ($t(936) = -2.175$, $p = 0.03$). At 6 months postpartum, there was no significant difference in maternal bonding difficulties. However, the difference in depressive symptoms was significant at 6 months (but not 6 weeks) postpartum (X^2 = 4.722, *df* = 1, *p* = 0.03, odds ratio = 1.56, 95% Confidence Interval 1.04 to 2.33). Moreover, depressive symptoms at 6 months postpartum were positively correlated with the level of maternal bonding difficulties (F (4, 717) = 24.070, p <.001, adjusted R^2 = 0.113) after controlling oxytocin exposure during birth, referral to NICU, and head circumference at birth.

Conclusion

Oxytocin-induced labor might be related to neonatal outcomes and mothers' well-being in the first 6 months after birth. Future research should further explore biological and psychosocial influences on mothers and children under the exposure to oxytocin during labor.

P2-C-268 - Early childhood autonomic reactivity and regulation: The role of prenatal-to-postnatal substance exposure and maternal depressive symptoms

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Details

According to the Developmental Origins of Health and Disease (Barker, 1998), prenatal stressors have lifelong effects on biobehavioral outcomes (e.g., autonomic regulation) for children; some of these relations may be mediated by continued postnatal exposures to these stressors (e.g., Dixit et al., 2016). Three of the most prevalent stressors especially among underprivileged low-income families are exposures to tobacco, cannabis, and maternal depressive symptoms in-utero (Oh et al. 2017; Haight et al. 2021). However, few studies have examined the relation between these exposures and both sympathetic and parasympathetic functioning in response to emotional arousal or examined the role of both tobacco and tobaccocannabis co-exposure. We hypothesized that these prenatal and postnatal risks would be associated with lower baseline respiratory sinus arrhythmia (BRSA)and higher prerejection period (BPEP), and higher RSA and lower PEP in response to a stressor at kindergarten (M = 69.56 months, SD = 6.00 months).

Mothers were recruited in the first trimester of pregnancy (N = 247; 52% Black/African American; 30% White; 18% Hispanic/Latinx; 8% Other) into one of three groups (see Table 1). Prenatal exposure was assessed using a self-report measure (Timeline Followback; Sobell & Sobell, 1992), maternal salivary assays during the second and third trimesters, and infant meconium assays upon birth. Prenatal substance exposure was dummy coded with non-using mothers as the reference. Postnatal tobacco exposure was indexed via child salivary assays (2, 9, 16, 24-months and kindergarten-age) and cannabis exposure via maternal self-report (2, 9, 16, 24, 36, and 48-months). Maternal depressive symptoms were indexed using the Beck Depression Inventory (Beck, Steer, & Brown, 1996) during pregnancy and at 2, 9, 16, and 24 months. Autonomic regulation was assessed at kindergarten using BRSA and BPEP (measured while watching an affectively neutral video) and reactivity using a frustration task from the Laboratory Temperament Assessment Battery (LabTab; Goldsmith and Rothbart, 1996). Average scores during the frustration task were used to assess RSA and PEP reactivity.

Results from a one-way ANOVA revealed significant group differences (see Table 1). Results from multiple regression using PROCESS macro (Hayes, 2022) showed continuity from the prenatal to postnatal period for depressive symptoms (b=.57, t=11.74, p<.001), and that higher postnatal depressive symptoms predicted lower child BRSA at kindergarten (b=-.05, t=- 2.49, p=.01). We also found a significant indirect effect of prenatal depressive symptoms on child BRSA via postnatal depressive symptoms, β=-.03, 95% CI [-.05, -.01]. The only significant predictor of RSA reactivity was BRSA, with higher BRSA associated with higher RSA reactivity (r=.66, p<.001; see Table 2). Similarly, PEP reactivity was only associated with BPEP (r=.85; p<.001). There were no significant predictors of child BPEP. Results highlight the role of maternal depressive symptoms as a predictor of child parasympathetic functioning. In addition, findings support the idea that both prenatal and postnatal depressive symptoms are negatively associated with child physiological functioning and that interventions aimed at improving parentchild well-being should focus on both prenatal and postnatal maternal depressive symptoms.

P2-C-269 - Examining associations between gut microbiome development and risk for anxiety in early life

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Details

The gut microbiome undergoes a sensitive period of development in the first three to four years of life. During this time there are rapid increases in the diversity of gut bacteria and large shifts in the composition of the gut microbiome (Stewart et al., 2018). The gut microbiome has been implicated in a range of psychiatric diagnoses in adults, including anxiety and depression (Evans et al., 2017; Foster et al., 2013). In young children, a few studies have documented associations between differences in the composition and diversity of the gut microbiome and early indicators of risk for the development of anxiety, including non-social fear (Carlson et al., 2021), functional brain connectivity (Gao et al., 2019), and internalizing problems (Querdasi et al., 2023). Most existing studies in this area have been cross-sectional, and the few studies that include repeated measurement of the gut microbiome have not focused on change in the gut microbiome across development as it is associated with behavioral outcomes.

As such, the goals of the current preregistered study are twofold: 1) to characterize change in the gut microbiome between 2 weeks and 18 months of age; and 2) identify how markers of the developing gut in early life are associated with anxiety risk at 30 months. In a sample of approximately 100 children and their caregivers, we will use latent change analysis and Dirichlet multinomial mixture modeling (DMM) to characterize structure and change in the gut microbiome across infancy. DMM is a data analysis technique that identifies latent groups based on ecological signatures of the gut microbiome. Alternative analytic strategies for aim 1 will leverage latent curve models to estimate inter-individual variability in intra-individual change in alpha diversity across infancy and early childhood. Regarding aim 2, informed by research linking RDoC constructs and risk for anxiety, we examine the links between gut microbiome clusters and constructs related to negative valence systems (infant affect) and social processes (social approach and avoidance), measured via a research assistant report on the Infant Behavior Record following a study visit. Theoretically justified covariates (e.g., nutrition, breastfeeding practices, newborn/birth complications, and number of people in the child's home) will be included.

We hypothesize that our sample will not cluster into multiple groups at 2 weeks, but that we will see at least 2 distinct clusters at 18 months. We expect that differences in cluster membership will be associated with differences in our measures of anxiety risk at 30 months. We also hypothesize that alpha diversity at 18 months will be associated with anxiety risk, and that greater change in alpha diversity between 2 weeks and 18 months will be positively associated with our measures of anxiety risk. This study will deepen our understanding of the dynamics of the developing gut microbiome in infancy, and it will provide foundational insight into the links between the gut microbiome and variation in mechanisms implicated in children's risk for anxiety. The full preregistration can be viewed at: https://osf.io/9ynqe

P2-C-270 - Everyday language environments of young children with Down syndrome

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Details

Children with Down syndrome (DS) often show language difficulties relative to typically developing (TD) children (Stojanovik, 2015). This can include delays in expressive and receptive language (Zampini & D'Odorico, 2013), and differences in word pronunciation (Martin et al., 2009). However, inter- and intra-individual variability is high in DS, and the extent of language difficulties can vary greatly (Karmiloff-Smith et al, 2016).

Researchers and practitioners are interested in identifying the sources of variability in language outcomes in DS, which can inform both theory and practical applications. While studies of language in controlled lab conditions (Pereira et al., 2014) can help researchers evaluate cognitive mechanisms for language learning, they do not necessarily reflect the environment in which children usually learn language. Most language learning opportunities occur at home during caregiver interactions (Tamis-LeMonda et al., 2019), so it is crucial to collect data about the typical speech environment (speech that children hear/produce) and understand how this may differ in DS and TD children. Automated technology, e.g. Language ENvironment Analysis software (LENA; LENA Foundation, 2014), can facilitate such research by reducing the burden of transcription and data coding.

In this study, we explored the amount of speech that children hear and produce in a typical day (~16 hours) using LENA. We compared adult word count (AWC) and child vocalisations for 23 children with DS (chronological age=35-58 months; mental age=15.5-34.5 months) to 329 TD children (chronological/mental age=2-48 months; published in LENA's Natural Language normative cohort study, Gilkerson & Richardson, 2008).

Firstly, we examined how the speech environment changes with mental age. AWC did not correlate significantly with mental age in DS ($\rho(20)=.14$, $p=.521$), which reflected Gilkerson and Richardson's TD findings ($r(327)=.04$, $p=.47$; Figure 1a). However, while child vocalisations did not correlate with mental age in DS ($\rho(20)=.24$, $p=.142$, one-tailed), they did correlate significantly in TD ($\rho(37)=.90$, $p<.001$, one-tailed; Figure 1b). The difference in the correlation coefficients is surprising, as expressive language abilities have been shown to increase with mental age in both DS and TD (Zampini & D'Odorico, 2013). These results may therefore suggest that maximum language abilities do not necessarily reflect daily language production.

Secondly, we tested for a relationship between AWC and child vocalisations in DS (Figure 2a), based on previously reported associations in TD (Huttenlocher et al., 2010). The correlation between child vocalisations and AWC was not significant in DS ($\rho(20)=.12$, $p=.298$, one-tailed), again differing from established TD patterns. These differences may suggest that LENA's child vocalisation count measures different vocalisations in DS and TD at this mental age; e.g., a high child vocalisation count may reflect frequent speech in TD, but more frequent pre-speech vocalisations in DS, due to language ability. Nevertheless, the DS child vocalisation count was found to correlate significantly with their expressive

language abilities (ρ(20)=0.44, p=.020, one-tailed; Figure 2b), suggesting LENA's child vocalisation measure does reasonably reflect the ability to produce speech-like vocalisations. The LENA outputs may, therefore, reflect a real difference in the relationship between actual child vocalisations and mental age in DS and TD.

P2-C-271 - Facilitating joint attention in young children with autism: A parent-mediated intervention

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Details

Introduction: Autism Spectrum Disorder (ASD) constitutes a neurodevelopmental condition marked by deficiencies in social skills, communication, cognitive functioning, and behavioral competencies with significant challenges in developing joint attention skills. Joint attention (JA) is a pivotal skill that develops in infancy and is the ability to share focus on an object or event with others and fosters early communication skills. When JA fails to develop, infants face challenges in developing communication and social interaction skills with cascading impacts on overall social and cognitive functioning. Since JA activities occur regularly in everyday contexts, the pivotal role of the parent-child relationship in parent-mediated interventions has a primary focus on enhancing social and JA interactions.

Objective: The current study compares the effectiveness of two JA activity-based interventions across different types of social interaction between parents and their young autistic children.

Methods: The Joint Attention in Autism (JAA) study was a 16-week parent-mediated intervention that focused on 10 parent-child dyads. For the purposes of this study, two distinct play activities were coded: (1) placing face pieces on a Mr. Potato head with scaffolding strategies provided by the parent; and (2) dump truck play (could include dumping objects in and out, rolling truck back and forth, etc. with specific strategies implemented to encourage turn-taking and joint attention. The *Dyadic Parent-Child Interaction Coding System* (DPICS) assessed parent-child social interactions that documented behavioral change practices. This coding scheme rates each parent-to-child verbalization, and categorizing as one of the following: Acknowledgement (AK), Informational Descriptions (ID), Unlabeled Praise (UP), Labeled Praise (LP), Reflective Statement (RF), Behavioral Description (BD), Questions (Q), Reflective Question (RQ), Indirect Commands (IC), Direct Commands (DC), and Negative Talk (NTA), and totaling the frequencies of each verbalization category for comparison. Child behavior was documented through compliance with parent-verbalized indirect and direct commands. We were able to assess parent verbalization changes between potato head and truck play activities across the different parent-child dyads across the 16 weeks.

Results: For this study, we compared weeks 1-3 (beginning weeks) and weeks 14-16 (ending weeks) of the intervention for the two activities. The potato head activity resulted in increased parent verbalization, specifically only in reflective statements ($F(3,4) = 5.81$, $p < .01$) and direct commands ($F(3,4) = 8.5$, $p = .033$). In contrast, the dump truck activity did not demonstrate significant change in any area of parent verbalization, including reflective statements ($F(4,1) = .167$, $p = .93$).

Conclusion: This study highlights the impact of joint attention interventions for young children with autism on early language skills in the context of parent-child interactions. The potato head activity depicted increased parent use of reflective statements and direct commands. Use of reflective statements demonstrated more responses to child behavior and/or verbalizations, indicating an increase in parent-child interactions. In contrast, the dump truck activity exhibited limited parent verbalization changes. Recognizing the pivotal role of parent-child interactions, early interventions centered on daily activities and focused on joint attention prove instrumental in cultivating essential early social responsiveness and early language competencies for young children with autism.

P2-C-272 - Developmental changes in attention and their relations to later childhood outcomes

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Details

DEVELOPMENTAL CHANGES OF ATTENTION AND THEIR RELATIONS TO LATER CHILDHOOD OUTCOMES

Background: Atypical development of visual attention is a potential endophenotype that underlies key features leading to the emergence of neurodevelopmental vulnerabilities such as autism spectrum disorder and ADHD. To date, it remains unclear whether social attention difficulties in autism and domain-general inattention skills in ADHD are common risk factors for later behavioural outcomes. This study aims to investigate developmental changes in different aspects of attentional behaviours over the first few years of life. Identifying subgroups of infants based on their developmental changes in attentional processes is a first step to understanding how earlier neuro-cognitive mechanisms underpin diverse trajectories and outcomes in later childhood. **Methods:** measures of attentional processes were examined longitudinally from 5 months to 36 months in a sample of (N= 166) infants enriched with diverse behavioural outcomes as they had either a low or high familial likelihood of developing neurodivergent outcomes. Infants were presented a 20-minute eye-tracking battery (BASIS and STAARS) of multiple visual attention tasks that included assessments of exogenous, endogenous, and social vs non-social attention (e.g. GAP-OVERLAP paradigms, face pop out). A multivariate latent growth mixture model was conducted to distinguish different classes of infants for each attentional domain. Further, classes were associated with cognitive, clinical, and behavioural outcomes at 36 months. **Results:** a preliminary data analysis shows positive relationships between a wide range of measures of attentional processes as reported in the correlation matrix table (Table 1). This study expects to observe: 1) a normative class for each attentional domain; 2) a class of reduced attentional skills in the exogenous and endogenous domains over the second year of life associated with higher ASD and ADHD traits and adaptive skills; 3) a plateau class with reduced attentional behaviours followed by a stable development associated with higher scores in ASD traits low adaptive skills and low cognitive functions; 4) in the social domain, a class with reduced attentional engagement towards social stimuli associated with higher scores on ASD traits but not on ADHD behaviours, low scores on communication and adaptive skills; 5) a class with lower attentional pattern of behaviours than the normative group, associated with scores below the thresholds for an ASD and ADHD diagnosis and normative cognitive, behavioural, and adaptive skills range. Findings will elucidate the heterogeneity of attentional behaviours and a better

understanding of the age range in which diversity in neurocognitive mechanisms can potentially be linked to atypical outcomes.

P2-C-273 - Temperament and social attention influence the developmental pathway from autism risk to the emergence of social communication in infancy

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Details

Background: Temperament reflects biologically rooted individual differences in reactivity and self-regulation in emotional, activation, and attentional processes. Temperament plays a fundamental role in shaping socioemotional and social-communicative outcomes. Examining temperament in young infant siblings of children with a confirmed diagnosis of autism spectrum disorder (ASD) facilitates the detection of early risk markers before an ASD diagnosis can be made. Evidence indicates that infants with elevated familial likelihood (EL) of ASD displayed higher negative affect and lower effortful control during the second year of life. Effortful control encompasses the functioning of goal-directed attention control. Another line of research has revealed that reduced attention to social information might be a biomarker for ASD. However, we know a little about the early-emerging individual differences of temperament associated with ASD risk, and how temperament may interact with social attention to modulate risk for ASD. The present study leverages longitudinal data collected in the first two years of life to examine the development of temperament, social attention, and their impacts on social communication abilities in infants with low (LL) and elevated likelihood (EL) of ASD. The study fits the call of the Special Issue, as it informs the temperamental risk and resilience for ASD.

Methods: Among all infants in the ongoing study, *N*=46 infants (22 males) were determined as EL, defined as having a full biological sibling with a confirmed diagnosis of ASD. Fifty-five infants (27 males) were at LL and had no first- or second-degree relatives with ASD. At 6, 9, and 12 months, infants' temperamental Negative Affect (NA) and Orienting/Regulatory Capacity (ORC) were examined using caregiver reports. Infants also completed a screen-based eye tracking task to assess attention to social information. Caregivers also reported on infants' social communication skills when infants were 24 months old.

Results: Across the first year of life, EL infants exhibited greater NA, *B*=0.19, *p*=.02, and reduced attention maintenance to social information, *B*=-8.42, *p*=.01, relative to LL infants. There was no group difference in ORC. However, higher ORC at 12 months predicted better social communication skills for EL, but not LL infants (group-by-ORC interaction effect: *B*=19.59, *p*=.02). Infant social attention at 12 months also moderated the link between ORC and social communication, *B*=-1.21, *p*=.02. That is, ORC was positively related to social communication skills at a low, *B*=1.04, *p*=.01, but not a high level of social attention.

Conclusion: NA and ORC are two temperament dimensions that remained stable during the first year of life for both EL and LL infants. However, EL for ASD was characterized by early emerging, elevated levels of NA. ORC supports the earliest form of self-regulation and voluntary control of attention. Our findings

suggest that efficient attention control may act as a protective factor that reduces the risk of developing poor social communication skills in EL infants and in infants who exhibit reduced social attention. The present study extends the current literature by indicating that both early temperament and social attention may modulate the risk for ASD and the development of social communication skills.

P2-C-274 - Understanding the role of anxiety in the early development of Autism Spectrum Conditions' sensory and social traits

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Details

Autism Spectrum Conditions (ASC) are characterised by differences in social communication differences and the presence of focused interests, repetitive behaviours and alterations in sensory experiences (APA, 2013). Autistic people report anxiety to be a priority in their everyday life, and it is estimated that about 60% meet diagnostic criteria for a clinical anxiety disorder (Kerns & Kendall, 2012; Kerns et al., 2021). However, it remains unclear whether early manifestations of anxiety precede or follow the emergence of core autism symptoms (Shephard et al., 2019; Ersoy et al., 2021). The current study adopted a prospective longitudinal design in 143 infants with and without a family history (https://www.basisnetwork.org/index.html) to test the relation between early brain measures of social and sensory processing and social and sensory functioning, early temperamental fear, and ASC traits at 3 years of age. We found that temperamental fear at 5 and 8 months predicted dimensional measures of social and sensory skills respectively at 36 months. Further, early neural correlates of social and sensory processing (N290 latency and MMN amplitude) at 8-10 months also predicted social and sensory profiles at 36 months respectively; but there were no associations between neural responses and early fear. Our results suggest that differences in sensory and social processing and differences in temperamental fear both emerge in early infancy, potentially representing additive components of an ASC developmental substructure. Such insights will improve our understanding of hierarchical effects in the manifestation of ASC-like behavioural traits and better target evidence-based interventions.

P2-C-275 - It takes a village: caregiver diversity and language contingency in the UK and rural Gambia

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Details

Introduction. There is substantial diversity within and between contexts globally in caregiving practices and family composition, which may have implications for early interactions and language exposure.

Hypotheses. We aimed to 1) evaluate and validate the Language Environment Analysis (LENA) for use in the Mandinka speaking families in The Gambia, 2) examine the nature (i.e., prevalence of turn taking) and

amount (i.e., adult and child vocalizations) of conversation that infants are exposed to from 12-24 months of age and 3) investigate the link between caregiver diversity and child language outcomes, examining the mediating role of contingent turn taking. Based on our prior work in this setting, we hypothesized that 1) we would see lower child vocalization counts in The Gambia compared to the UK, 2) LENA measures of child vocalizations would increase with from 12 to 18 and 24 months in both cohorts and 3) LENA contingent turn taking (CTT) counts at 12 and 18 months would be positively associated with child vocalization counts (CVC) at 18 and 24 months in both cohorts. We further hypothesized that 3) caregiver consistency would be associated with CTT counts within age points.

Study population. We draw on data from the Brain Imaging for Global Health project (BRIGHT, [1, 2]), which longitudinally examined infants in the UK and in rural Gambia, West Africa. In The Gambia, households are commonly characterized by multigenerational, frequently polygamous family structures, which, in part, is reflected in the diversity of caregivers a child spends time with.

Methods. We obtained naturalistic seven-hour-long LENA recordings at 12, 18 and 24 months of age from a cohort of N=204 infants from Mandinka speaking households in The Gambia and N=61 infants in the UK. We examined developmental changes and site differences in LENA counts of adult word counts (AWC), contingent turn taking (CTT) and child vocalizations (CVC). In the larger and more heterogenous Gambian sample, we also investigated caregiver predictors of turn taking frequency. We hereby examined the number of caregivers present over the recording day and the consistency of caregivers across two subsequent days per age point. We controlled for children's cognitive development via the Mullen Scales of Early Learning (MSEL).

Results. Our LENA validation showed high internal consistency between the human coders and automated LENA outputs. All LENA counts were higher in the UK compared to the Gambian cohort. In The Gambia, controlling for overall neurodevelopment via the MSEL, CTT at 12 and 18 months predicted CVC at 18 and 24 months. Caregiver consistency was associated with CTT counts at 18 and 24 months (Figure 1). The number of caregivers and CTT counts showed an inverted U-shape relationship at 18 and 24 months, with an intermediate number of caregivers being associated with the highest CTT frequencies (Figure 2).

Discussion. The LENA provided reliable estimates for the Mandinka language in the home recording context. We showed that turn taking is associated with subsequent child vocalizations and explored contextual caregiving factors contributing to turn taking in the Gambian cohort.

P2-C-276 - Neural and behavioral correlates of receptive-expressive phenotypes in infants and toddlers with autism symptoms

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Details

Background: Toddlers with autism are at increased risk of language delay and are more likely to show uneven receptive-expressive language levels ("atypical" language profiles), characterized by stronger

expressive language skills than would be expected of their receptive language level (Hudry et al., 2010). This study uses a multimodal approach to identify behavioral and neural (electroencephalography; EEG) mechanisms that may contribute to within-individual differences in receptive-expressive language abilities among 12-23-month-olds with autism symptoms.

Method: Participants were 12-23-month-olds (*N* = 70; 20% female; mean age = 18.1 months) with autism symptoms recruited from community-based settings for an early intervention study (Gulsrud et al., *under review*). At baseline, task-free (resting-state) EEG data were collected using a high-density 128-channel system. Receptive and expressive language age equivalent (AE) scores from the Mullen Scales of Early Learning were used to quantify within-child discrepancies between receptive and expressive language levels (Difference Score = Receptive AE – Expressive AE; Ratio Score = Receptive AE/Expressive AE) and to group children into expressive advantage (EA; Ratio Score < .90), receptive advantage (RA; Ratio Score > 1.1), and Balanced language profiles (Seol et al., 2014). Spearman's correlation and robust ANOVA (Mair & Wilcox, 2020) were used to test for associations between receptive-expressive language phenotypes and behavioral variables. Cluster-based permutation analyses (Maris & Oostenveld, 2007) tested for associations between spontaneous relative theta (3-6 Hz) and alpha (6-9 Hz) power and receptive-expressive language phenotypes.

Results: Over 40% of children had an EA profile (*n* = 29), whereas RA (*n* = 24; 34%) and Balanced profiles (*n* = 17; 24%) were less common. There were no significant associations between Difference Scores or Ratio Scores and chronological age, cognitive functioning, autism symptom levels, or joint attention skills (Table 1), consistent with results of ANOVAs testing for differences across language profile groups (p's > .264). Cluster-based permutation analyses revealed significant associations between spontaneous theta power and Difference Scores ($T = 9.54$, $p = .032$) and Ratio Scores ($T = 11.40$, $p = .028$). An increasing receptive advantage was associated with higher levels of theta power (Figure 1). Follow-up analyses revealed significant differences between language profile groups in left frontal relative theta power ($F(2,67) = 3.50$, $p = .036$) but not right frontal theta power ($F(2, 67) = 1.25$, $p = .293$). Children with EA profiles had significantly lower levels of relative theta power in the left frontal region than children with RA profiles ($t(51) = 2.58$, $p = .013$). Relative theta power was not significantly associated with receptive or expressive language AE scores examined in isolation. There were no associations between receptive-expressive phenotype and relative alpha power.

Conclusions: The present findings suggest that children with lower levels of relative theta power are more likely to have comparatively delayed expressive language skills relative to their receptive skill level. While typically regarded as a marker of neuromaturational delay in early childhood (e.g., McLaughlin et al., 2010), the increased availability of endogenous theta oscillations during early toddlerhood may confer resilience against more profound receptive language delays in children developing autism. This study is a critical step toward understanding neural mechanisms driving typical and atypical language development in emerging autism and developing early markers to identify children who may benefit the most from language intervention.

P2-C-277 - Early linguistic comprehension of preterm and full-term infants: An eye-tracking and pupillometry study

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Details

Introduction: Preterm birth is a risk factor for language delay. Literature identified early receptive language skills as good predictors of later language development (Marchmann et al., 2019). Eye-tracking enables the investigation of attentional mechanisms underlying language comprehension by providing a verbal-free measure (Loi et al., 2017). The present study aimed to assess early linguistic comprehension by investigating behavioral data (i.e., proportion of gaze toward the target) and pupillometry data (i.e., pupil diameter dilation) in preterm and full-term infants.

Methods: Fifty infants, mainly exposed to the Italian language, were recruited: 20 born preterm (8 females; gestational age=29.2 weeks), recruited at the University Hospital of Bologna, and 30 born full-term (12 females), recruited in two kindergartens. Proportion of gaze toward the target and pupil diameter dilation of preterm (corrected mean age= 28.6 months) and full-term (chronological mean age= 26.9 months) infants were recorded with eye-tracking during a Looking-While-Listening task. The task required the infant to look at two images while listening to a voice labeling one of them. The experimental design involved a target and a distractor (semantic vs non-semantic) and 3 phases: preceding (*pre-label*), concurrent linguistic label (*label*), and subsequent (*post-label*). Generalized additive mixed effects models (GAMMs) were used to analyze accuracy (proportion of gaze toward the target) and infants' allocation of attentional resources (pupil diameter dilation).

Results: During the post-label phase, both groups showed a significant increase in the proportion of gaze toward the target, but preterm infants displayed less accuracy and more inter-individual variability. Both groups also showed a significant increase in pupil diameter dilation, indicating infants' allocation of attentional resources growth, with a greater effect for the semantic distractor, remaining high over trials in preterm infants, whereas decreasing in full-term infants.

Discussion: The results showed reduced accuracy and high variability in preterm infants' early linguistic comprehension and less functional attentional strategies. The use of eye-tracking technology proved to be useful for investigating the mechanisms involved in early receptive language. These findings could constitute a first base for planning early assessment and intervention supporting attention and linguistic comprehension in preterm infants.

P2-C-278 - Sensitivity to audio-visual synchrony for social and non-social stimuli in infant siblings of autistic children

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Details

Over the last decades, progress has been made in identifying early markers of Autism Spectrum Disorder (ASD), which are essential for implementing timely intervention programs at very young ages. Furthermore, there is a growing interest in identifying reliable behavioral predictors that may serve as useful tools for early detection of at-risk individuals. Since the high heritability of ASD is established, an increasing number of prospective studies have reported that infants at higher likelihood of autism (HL-ASD), i.e. siblings of children with a diagnosis of ASD, show atypical development in domain-general, perceptual, attentional and motor abilities compared to typical likelihood of ASD (TL) infants. Specifically, HL-ASD individuals show poor performance in tasks that require selective attention, detection of temporal synchrony and integration of information from visual and auditory modalities (Audio Visual Integration, AVI), especially in response to social compared to non-social stimuli. These skills are essential abilities for mastering higher-level socio-communicative skills. However, few studies have examined behavioral processing of AVI in HL-ASD infants during the first year of life.

This study aims: (1) to explore whether and to what extent differences in social and non-social AVI skills can differentiate HL-ASD from TL infants, applying eye-tracking (ET) technique and, (b) to assess the association between early AVI skills and clinical outcome measures of infant's development.

This research is part of a larger longitudinal study on HL-ASD infant siblings. Data collection is ongoing and the present study includes HL-ASD and TL infants recruited at 6, 9 and 12 months and a follow-up evaluation of sensory, cognitive and communicative development is collected at 18 and 24 months. Preliminary findings are available for 41 HL-ASD and 33 TL infants. At each time-points all children are assessed with an experimental protocol testing two different conditions: a) social (hands clapping) and b) non-social (drumming) AVI skills using an ET preferential looking paradigm (see Figure 1a). Stimuli are presented side by side in synchronous and asynchronous modalities (350 ms delay from the sound onset). ET preferential looking parameters are recorded using a Tobii ProSpectrum 300 Hz system.

Preliminary results on synchronous/asynchronous looking time proportions showed a main effect of condition ($F(1,135)= 3.90$ $p=.05$,see Figure 1b). In social conditions, both groups seem to show a preference for synchronous compared to asynchronous conditions during development (from 6 to 12 months), and this looking pattern seems to be stronger in TL compared to HL-ASD. The follow-up is ongoing and social communication outcome at 18 and 24 months will be available for all infants. This study could offer a better understanding of behavioural correlates of AVI in early developmental trajectories and provide new insights for critical time windows and consequently for early individualized interventions in ASD.

P2-C-279 - Caregiver goals are causally associated with sensitivity and warmth during interactions with their 6-month-olds

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Details

Background: Variations in exposure to caregiver sensitivity (behaviors that signal awareness of a child's needs, emotions, interests, and capabilities; Ainsworth et al., 1978, Kok et al, 2013), and caregiver

warmth (the degree of positive, caring, and affectionate interactions) are each associated with child psychosocial, cognitive, and physiological developmental outcomes (Hirsh-Pasek & Burchinal, 2006; Yule, et al., 2020). Given the importance of caregiver sensitivity and warmth in shaping infants' long-term outcomes, in this preregistered study (https://osf.io/35fnv), we examined whether levels of these two caregiving dimensions could be influenced by a goal manipulation. Specifically, we explored the effect of two different strategies advocated in some caregiving interventions (e.g., PCIT; Funderbruk & Eyberg, 2011; (1) narrating a child's actions or (2) physically replicating the child's vocalizations and actions), in relation to a no manipulation group, during structured caregiver–child interactions either in the laboratory or via Zoom. **Methods:** Caregivers (all birthing parents) and their 6-month-old infants (N=80; 65% male infants) from the Nashville Area were recruited from the Brain and Behavior Infant Experiences (BABIES) project to participate in a 10-minute "free-play" interaction. These interactions were coded in 2-minute epochs by trained and reliable raters using the 1-7 scale from the PCIRS (Belsky, et al., 1995) for both sensitivity and positive regard (warmth), which were examined in relation to the manipulation. Prior to the final epoch (i.e., last 2 minutes), a subset of dyads received additional instructions in which caregivers were asked to a) narrate their child's actions like a "sportscaster" (i.e., "narrate"; n = 22) or b) mimic their child's vocalizations and behaviors (i.e., "mimic"; n = 21). While both experimental manipulations were selected to increase the likelihood that infants experience their caregivers as attending to them, narration has the benefit of using language to organize the experience, whereas mimicking has the benefit of being fully child-led and therefore non-intrusiveness. A control group (n=37) of dyads received no instructions and continued play as usual. **Results:** Sensitivity and warmth in the final epoch were examined after covarying for each domain in the immediately prior epoch (epoch 4) to adjust for individual differences prior to the manipulation. Caregivers in dyads randomized to the narrate condition demonstrated significantly greater sensitivity than those in the control condition (Cohen's d = 0.64 [0.12, 1.17], p=.011). Similarly, there was evidence of greater warmth in dyads assigned to the narrate (vs. control) condition (Cohen's d = 0.43 [-0.09, 0.95], p=.054). Dyads assigned to the mimic condition did not statistically significantly differ from other group. **Discussion:** This study provides experimental evidence to suggest that providing caregivers with explicit goals to narrate their child's action is associated with more sensitive and warm interactions relation to no instruction. From an attachment perspective, an infant's signal of being attended to and understood is important for developing secure attachments. Our data provide a practical step in providing caregivers with a potential strategy that is likely to increase sensitivity and warmth when used.

P2-D-280 - Bilingual primary caregivers and their children match their language choices during interactions

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Details

Bilingual children's language abilities are associated with their linguistic experiences, such as the amount and richness of speech that they hear in each language (Ramírez-Esparza et al., 2017), caregivers' language strategies when speaking multiple languages (Orena et al., 2019), the quantity and type of code-switching between languages that children hear (Kremin et al., 2020), and caregivers' attitudes towards bilingualism (Kircher, et al., 2022). Yet, language use occurs bidirectionally – when caregiver(s) and children engage in

a conversational exchange. It is unknown to what extent bilingual families and their children adapt their language choices to each other during interactions. This study explores bilingual families' language use during free play sessions across two communities: French-English families in Quebec (Canada) where both languages have high sociolinguistic status, and Spanish-English families in New Jersey (United States) where English is generally signalled by society as having higher status than Spanish. We asked: 1) Do caregivers and children match their use of each language? 2) Does matching vary by the presence of different caregivers? 3) Does matching vary across bilingual communities?

Forty 18-to-35-month-old infants and their bilingual families were video-recorded at home during two 20-minute play sessions (n = 20 French-English bilinguals and n = 20 Spanish-English bilinguals). On Day 1, infants played with one of their primary caregivers. On the Day 2, additional household members also participated (including other parents, siblings, nannies, and/or grandparents). We coded onsets and offsets of all utterances and tagged each utterance for speaker identity and language. To quantify language use, we calculated the proportion of utterances in each language (English, French/Spanish) on each day, both for children and for caregivers.

Correlations show that across both communities, primary caregivers and their child's language choices strongly matched on Day 1 during one-to-one interactions (French-English r = 0.76, p < 0.001; Spanish-English r = 0.61, p = 0.004), as well as on Day 2 during multiparty interactions (French-English r = 0.60, p = 0.015; Spanish-English r = 0.60, p = 0.039). Thus, primary caregivers and children used each language in similar proportions regardless of whether other family members were present (Figure 1). Language choices from other individuals on Day 2 did not match the child in French-English families (r = 0.21, p = 0.437) and were marginally correlated in Spanish-English families (r = 0.51, p = 0.088).

Across the two bilingual communities, primary caregivers and their children tailor their language choices to each other. This coupling might help support bilingual development across different family contexts of interaction, especially when other individuals use different languages than the child. We did not find differences across communities, however, French-English family members seem to be less matched with their children than Spanish-English bilinguals. This could reflect different family strategies, perhaps associated with community norms of language use. Future work will be needed to clarify that. These results reveal the central role of primary caregivers in bilingual development, as well as the need to better understand the effects of family context in early bilingual experiences.

P2-D-281 - Media mayhem: Effects of electronic media and hearing loss on language development

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Details

Infants typically learn language from caregivers' infant-directed speech (IDS), characterized by exaggerated intonation, clear vowels and consonants, repetition, and simple grammatical structure (e.g., Fernald, 1992). Previous research suggests that IDS also draws the attention of children with typical

hearing and those with cochlear implants (CIs), which contributes to subsequent language development (Wang et al. 2017). However, the quantity and quality of language during caregiver-infant interactions may decrease in the presence of electronic media. Children with CIs experience greater difficulties with language development in noisy environments and demonstrate an increase in listening effort and executive function (EF) delays (Beer et al., 2014; Winn & Teece, 2022). Electronic media thus not only limits the amount of IDS from adults to children but also creates a more complex listening situation for which children must navigate. When attuning to media and speech simultaneously, effortful listening and deficits in EF will likely influence the cognitive capacity of children with CIs to focus on linguistic information in the speech input. The purpose of this study is to explore the relationship between electronic media exposure in the homes of children with cochlear implants and normal hearing (NH) and later language assessments to provide novel information on the impact media might play in the language development of children with CIs.

The home-auditory environments for 16 CI and 25 typically hearing children at 9 months of hearing age are currently being evaluated using Language ENvironment Analysis (LENA) recordings. The first 5 minutes of each hour of each day-long recording is coded for conversational turns (CTs), commands and the tone used from parents, statements from the parents without a child response, child vocalizations without a parent response, the presence of television or media, the use of adult- or infant-directed speech, and other situational factors. After all data are collected, statistical analyses will be conducted to determine potential correlations between parental engagement, electronic media, and language development in both populations. Table 1 displays quantitative information coded to date (4 CI and 3 NH participants).

We predict that quantity and quality of caregiver speech will decrease with media exposure, leading to lower language assessment scores for CI children. Furthermore, the nature of the interactions between parents and children may lead to differences in types of family environments (e.g. supportive, controlling, etc.), which in turn can have a positive or negative influence on the language input and subsequent acquisition in the children. Findings will clarify proper media use and caregiver speech with CI children to ensure appropriate language development.

P2-D-282 - Predicting toddlers' language development from Age 2 to 3: Insights from the QUILS:TOD

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Details

Children's early language skills significantly impact their later academic success and social development (e.g., Can et al., 2013, Roben et al., 2013), suggesting that early evaluation of children's language skills is essential. Indeed, research underscores the impact of language interventions on academic and social outcomes when implemented before a child enters school (Roberts & Kaiser, 2015), particularly benefiting toddlers over older children (Law et al., 2004). However, fewer language screening options exist for toddlers compared to older children. The Quick Interactive Language Screener for Toddlers (QUILS:TOD) was designed to address this concern by measuring 24- to 36-month-old children's

receptive vocabulary, syntax, and language-learning processes on a tablet (Jackson et al., 2023). Here, we explore the QUILS:TOD's predictive validity by asking: How does performance on three components of language—vocabulary, syntax, and process— measured by the QUILS:TOD at age 2 predict to children's later language proficiency on the QUILS at age 3?

Thirty-one (12 female) children participated in this longitudinal study at two (M_{age} = 29.60, *SD* = 3.50) and three years of age (M_{age} = 42.70, *SD* = 3.98). Children's later language development was assessed by the QUILS:TOD's predecessor, the QUILS, a version designed for children between 36- and 72-month-old that measures the same three areas of language. Overall scores for the QUILS:TOD and QUILS were created by combining vocabulary, syntax, and process scores. Pearson correlations indicated a significant relation between overall performance on the QUILS:TOD and QUILS (r = .64, p < .001). Correlations between language components across the two assessments revealed significant relations, emphasizing the interconnectedness of the language components across the two assessments (Table 1).

To explore whether performance on individual QUILS:TOD components explained variance in children's performance on the QUILS, we conducted two regressions using the months between assessments as a covariate in each model. In the first model, a regression with the QUILS:TOD overall score as the predictor and the QUILS overall score as the outcome variable was significant and accounted for 42.3% of the variance, F (2, 28) = 10.24, MSE = 46.46, p <.001. Specifically, overall performance on the QUILS:TOD predicted overall performance on the QUILS (ß = .63, *SE* = .09, p < .001). Next, we conducted a multiple regression to assess how performance on each component of the QUILS:TOD (predictor variables) contributed to overall performance on the QUILS (outcome variable). Results revealed that the model significantly accounted for 50.0% of the variance in children's overall performance on the QUILS, F (4, 26) = 6.51, MSE = 40.21, p <.001. Interestingly, only the QUILS:TOD syntax score was a significant predictor of children's performance on the QUILS (ß = .51, SE = .09, p = 0.005) (Figure 1).

Our findings suggest that the QUILS:TOD is a promising tool for early language screening. Additionally, results revealed the critical role syntax plays in predicting later language skills, emphasizing the importance of evaluating diverse language components in early childhood language assessments.

P2-D-283 - Prosodic features of maternal speech at 18–24 months are linked to children's language skills at 5 years of age

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Details

The nature of speech to which infants are exposed impacts their language development (Huttenlocher et al., 1991; Newman et al., 2016), and infant-directed speech (IDS) has been widely studied. However, investigations of the effects of syntactic and pragmatic characteristics of IDS have only revealed a limited impact of syntactic characteristics, e.g., mothers' use of Yes/No questions correlates with infants' auxiliary verb use six months later (Newport, 1977).

In previous studies, however, syntactic properties were analyzed without taking prosodic phrasing into account (Vendittе et al., 2008). When IDS is analyzed with reference to prosodic phrasing, a more robust impact may be found because prosodic emphasis is a prominent property of IDS. Many previous studies evaluated children's language skills at a relatively young age (i.e., 2–3 years), which may be too early to determine language outcomes. In the present study, we examined the effect of mothers' speech in terms of prosodic features, focusing on language outcomes when children reached 5 years of age.

We utilized the Riken Japanese Mother-Infant Conversation Corpus (R-JMICC) (Mazuka et al., 2006), which contains recordings of conversations between mothers and their infants. Data from 19 mothers (25–38 years)and their infants (18–24 months) were analyzed. The mothers were asked to play with their infants for 30 min as they would at home, using picture books and toys. The same children were then assessed at 5 years of age, using the Language Communication Development Scale (LC scale, Otomo et al., 2008), which consists of 3 subscales: age-based expressive language quotient (ELCQ), receptive language quotient (RLCQ), and the nonverbal interpersonal communication skill, situational awareness, understanding emotional states and rules (CLCQ) subscale.

R-JMICC is included intonation labeling that is based on the framework called X-JToBI (Maekawa et al., 2002). In present study the prosodic features of the mothers' speech were measured, including the mean duration of each utterance, mean number of intonation phrases (IP), accentual phrases (AP), and mean number of words per utterance. The mean f_o and f_o ranges of each utterance were also measured. We examined whether these measurements correlated with children's language skills measured by the ELCQ, RLCQ, and CLCQ.

Children's ELCQ scores positively correlated with the mean utterance duration and the number of words/AP/IP per utterance of maternal speech, but RLCQ and CLCQ scores did not (Table 1). In contrast, the pitch characteristics of utterances, i.e., average f_o and f_o ranges, correlated strongly with RLCQ and with ELCQ (Table 2).

These results indicate that the prosodic features of mothers' speech to infants at 18–24 months of age correlates positively with children's language skills at age 5, suggesting that mothers' speech during infancy has a long-lasting impact on children's language development. Interestingly, children's expressive language skills were positively correlated with prosodic units and f_o range of IDS, while receptive skills correlated only with pitch characteristics. Considering children's receptive language skills are generally more advanced than their expressive skills, prosodic features may play a greater role in the earlier stages of language development.

P2-D-284 - Investigating brain specialization for song and speech at birth

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Details

For humans, speech and music represent the most abstract, structured, and therefore cognitively complex, use of sounds. Processing both speech and music requires perceiving and integrating their distinctive, although in some respects similar, acoustic dimensions (Albouy et al., 2020). Several studies in the literature have extensively explored similarities and differences in how the adult brain perceives music and speech (Peretz & Zatorre, 2005; Zatorre, 2013). By contrast, little is known about whether infants, and especially newborns, process these two types of auditory stimuli similarly.

Existing studies suggest that the newborn brain is already lateralized for the prenatally heard language (e.g., Peña et al. 2003, Sato et al. 2011), activating the left auditory cortex, as well as for instrumental music, activating the right auditory cortex (Perani et al., 2010; Perani, 2012). However, there is little evidence about the neurocognitive mechanisms underlying the perception of song at birth. Processing song is particularly relevant, as it requires processing musical and linguistic information simultaneously. Importantly, song is a natural ecological stimulus for young infants, as caregivers often hum or sing spontaneously, even if they don't have formal musical education.

In this work, we therefore explore how the newborn brain processes speech, sung and hummed melodies at birth. We used near-infrared spectroscopy (fNIRS) to measure brain responses in the frontal, temporal, and parietal areas bilaterally of 1-4-day-old Italian newborns, while newborns listened to three auditory conditions: (i) speech utterances in Italian; (ii) sung songs in Italian; and (iii) hummed song melody. Spoken sentences carry linguistic information; sung sentences add a melodic component to speech, while hummed melody only carries the musical component, without linguistic information.

Data collection is currently ongoing. Figure 1 shows preliminary grand average responses per condition for 9 participants, using the data processing pipeline described in Gemignani & Gervain (2021).

Overall, this work will bring important insights in the understanding of whether music and language, and more specifically song and speech, rely on distinct or overlapping neural mechanisms, and the extent to which this specialization depends on biological mechanisms already operating in the womb.

P2-D-285 - Joint attention differences between mothers and fathers

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Details

Intro: Outdated models of family life often assume that fathers interact minimally with their infants, and are often assumed to be much like babysitters as opposed to caregivers. This has led to a lack of

research on the differences between mothers and fathers' interactions with their infants (Cabrera et al., 2018). The research that does exist suggest that there may be significant differences, although differences in methods and results across studies makes interpretation difficult (Ataman-Devrim, et al., 2023; Martins, et al., 2014; Pierce, et al., 2015). Importantly, the literature that does exist on joint attention in secondary caregiversm (often fathers) does not always include language outcomes.

This study used video recordings of mothers and fathers interacting separately with their infant. From these recordings we have coded joint attention episodes to determine if there are differences between mothers' and fathers' interactions with their infants. We hypothesize that there will be measurable differences, but that primary caregiver interaction patterns (typically the mother) are more predictive of language outcomes.

Methods: There were two sessions, each involving dyadic and triadic interactions with a parent and 9-11 month old infant with and without toys. These sessions were coded for disruptive, unilateral, asymmetrical and symmetrical (turn taking) patterns (Hsu and Fogle, 2001).
In addition, the Mullen Scales of Early Learning screened for developmental delay. Each parent was also administered the SPEAK (Suskind, 2018), to measure parent expectation and knowledge, and the TOPSE, a measure of parenting self-efficacy (Bloomfield & Kendall, 2012). Two months after the final session, the parents filled out the CDI to obtain estimates of expressive and receptive lexicon. Note that the study is being conducted in both Israel and the USA, but currently we only have data from Israel. We expect to have data from both countries at the conference.

Results/Discussion: Preliminary data are from six families. Both fathers and mothers received high and comparable scores in the SPEAK questionnaire for parent expectations and knowledge, as well as in the TOPSE questionnaire for self-efficacy. In both dyadic and triadic episodes, fathers and mothers predominantly engaged in unilateral, asymmetric, and symmetric interaction patterns, spending significantly less time in disruptive or unengaged interaction patterns.
Furthermore, in both dyadic and triadic conditions, fathers and mothers spent more time in the unilateral patterns over symmetric and asymmetric patterns, despite their attentiveness to infants' initiations. This suggests that interactions with infants aged 9-11 months may be influenced by the infants' ability to pay attention, initiate, and respond to the parent.
During dyadic episodes, fathers exhibited more symmetric and asymmetric interaction patterns compared to mothers, who displayed more unilateral patterns. This observation hints that fathers might be more successful in capturing infants' attention during one-on-one interactions. However, in triadic episodes, mothers engaged in more symmetric patterns of interaction with the infants. We are currently analyzing the correlation between these measures and the CDI.

P2-D-286 - Language in the preschool classroom and at home

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Details

Language development occurs in macro-scale environments, which affect infants' language exposure and use. The home and preschool are two salient environments in which infants spend a large portion of their waking day. Relevant research indicates that the type of activity and time of day influence language experiences in both home and school settings, and that the quantity and quality of language at school were similar to middle- and high-SES homes (Murray et al., 2006; Soderstrom & Wittebolle, 2013).

Automated tools, such as the Language Environment Analysis (LENA) System, has expedited infant language environment research by automatically distinguishing and quantifying infants' vocal environments. Using LENA, we quantified adult words (AWC), child vocalizations (CVC), and conversational turns (CTC) occurring between an adult and a child in the classroom (N=12; M=36.9 months, SD=3.3) and at home (N=15; M=20.9 months, SD=10.71). We specifically focused on language experiences over multiple classroom (85 observations; 7.08 mean recordings per infant, SD=2.68) and home (129 observations; 8.6 mean recordings per infant, SD=3.16) observations.

Table 1 details descriptive statistics of AWC (Fig. 1b & 1c), CVC (Fig. 1e & 1f), and CTC (Fig. 1h & 1i) in both settings. Unpaired t-tests did not indicate differences between the means of AWC (p=0.480; Fig 1a), CVC (p=0.138; Fig 1d), and CTC (p=0.0874; Fig 1g) for the infants in the two contexts. However, there was significantly higher variance in all measures at home than in the classroom: AWC (F(14,11)=3.43, p=0.0462), CVC (F(14,11)=25.52, p<0.001), and CTC (F(14,11)=25.97, p<0.001) (Table 1).

Intraclass correlation coefficient (ICC) using each observation for each infant as input describe how the degree of consistency in the values for each variable within infant. ICCs suggested more consistency of variables between observations within infant at home than in the classroom. For AWC, ICC at home was 0.148 compared to ICC in the classroom of 0; for CVC, ICC at home was 0.648 compared to ICC in the classroom of 0.243; for CTC, ICC at home was 0.569 compared to ICC in the classroom of 0.243.

Despite infants at home having a much wider range of ages, the two groups showed no mean differences of language in preschool and at home. However, there was significantly higher variance between observations at home than in the classroom. Moreover, individual differences were more stable in the home than in the classroom. This indicates that subsets of infants in the home experienced and produced richer and some subsets produced and experienced lower language levels than infants in the classroom.

Our research suggests that children show more consistency--both in their exposure to adult language and in their own vocal productions and turn-taking--at home than children do in preschool. Likewise, variation between children appears more accentuated at home than in preschool. To better understand these findings, we have initiated the next phase of the study with concurrent home and preschool observations for a new cohort of infants to learn more about language differences in the two contexts.

P2-D-287 - Videos versus flyers: How to best deliver distant parent coaching to improve language input

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Details

Young children rely heavily on the language input that they receive from their parents to acquire language skills. There are marked gaps in accessibility to resources that support parents' learning of strategies that promote children's early language development. These gaps are associated with shortages of healthcare professionals, service gaps in rural areas, and racial and economic disparities among other factors (Cason et al., 2012; McManus et al., 2020). We investigate the effectiveness of video-based and print-based distant parent coaching models on parent's use of indirect language stimulation techniques known to promote language development.

Previous research suggests that the use of indirect language stimulation techniques, such as expanding and imitating what the child says (among others strategies) can positively impact child language development (Rescorla & Dale, 2013). However, existing work on this topic has primarily focused on in-person parent coaching. The present work examines whether video-based and print-based distant parent coaching models can be successful for improving the characteristics of the language input that caregivers provide, and in turn enrich parent-child interactions. Specifically, we examined whether different ways of training parents on indirect language stimulation techniques can help increase (i) the quantity and (ii) the variety of words spoken during an interactive book reading activity.

Participants included parent-child dyads. Children were aged between 12-18 months (*M*=14.9; N=27 to date). Using a between-subjects design, participants were randomly assigned to one of three conditions: (i) A video condition, in which parents watched a pre-recorded video (with examples) on ways to use indirect language stimulation techniques, (ii) A print condition, in which parents read a 1-page flyer summarizing indirect language stimulation techniques, and (iii) A control condition, in which parents read a 1-page flyer on nutrition for healthy toddlers (i.e., an unrelated topic). Caregivers received the assigned learning material (i.e., video, language flyer, or nutrition flyer) 3 days prior to the book reading activity which was held virtually over Zoom. During the activity, we screen shared a children's e-book. Caregivers were given remote control to access the e-book and independently flip through the pages of the e-book. The activity was recorded for offline coding.

Caregivers in the video and print condition used more indirect language stimulation techniques compared to the control condition. First, as shown in Figure 1, caregivers in the video and print groups used a greater number of total words during the book reading activity (M=474 and M=450 respectively) compared to the control condition (M=332). Second, as seen in Figure 2, the number of different words was also higher for the video (M=177) and the print conditions (M=176), compared to the control group (M=142). Additional data will be available by the time of the conference. Taken together our data suggest that video- and print-based distant parent coaching models can positively impact caregiver's language use when interacting with their children. These findings serve as support for the creation and distribution of distant video and print-based parent coaching materials that are cost-effective, trainer-time efficient, consistent in training delivery, and accessible to many diverse communities.

P2-D-288 - Infant neural responses to language: A meta-analysis

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Details

Human speech perception is known to start developing at birth, if not sooner (Werker & Gervain, 2013; Werker & Tees, 1984). While adult speech processing is well-established to be in the frontal and temporal brain regions lateralized in the left hemisphere (Geschwind & Levitsky, 1968; Szaflarski et al., 2002), much less is known regarding the spatial organization of speech perception in infancy (Bortfeld et al., 2009). Infant findings are inconsistent between bilateral (e.g., Fava, Hull & Bortfeld, 2014; Naoi et al., 2012) and lateralized, left hemisphere activation (e.g., Altvater-Mackensen & Grossman, 2016; Minagawa-Kawai et al., 2011). This pre-registered meta-analysis – for the first time in the field – examines studies using functional near-infrared spectroscopy (fNIRS) to determine the pattern of neural engagement in frontal and temporal regions when infants are exposed to speech (Open Science Framework registration: https://osf.io/92ejt/, approved 19 February, 2023). We collected studies by searching the UBC Library and PubMed and by sending a call for papers to the ICIS Listserv. Inclusion criteria involves infants from birth to 12 months showing no health concerns and presented with speech stimuli. We have first analyzed data from infants aged 3-12 months (20 papers), and the next phase of the project will expand our sample, involving infants from birth. We follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocol's (PRISMA-P) guidelines, extensively reviewing our inclusion criteria to ensure reliable findings (Quintana, 2015; Selçuk, 2019). To analyze our findings, multinomial logistic regressions will be performed on mean age, experimental baseline, modality (auditory or audiovisual), and speech stimulus (native/non-native language, prosody, continuous speech, vowels, syllables, and sentences) on our regions of interest (ROIs, temporal and frontal). To summarize the findings of the papers we have collected thus far (Figure 1), we found that, in the frontal lobes, 21% of publications reported bilateral activation, 17% found left-lateralized activation, 7% found right-lateralized activation, and 55% found no significant results. Meanwhile, in the temporal lobes, nearly half of the publications (49%) found bilateral activity, while 20% reported left-lateralized activity, 10% reported right-lateralized activity, and 21% found no significant activity. From these summary statistics, left-lateralized responses were not the most common response reported in the literature. Depending on the brain region either no activation or bilateral activation was the most common pattern of response. Further analysis, using multinominal logistic regression, will clarify the role of age, modality and stimulus on these overall findings. This meta-analysis will synthesize the findings of studies looking at various infant speech processing using fNIRS to determine a common ground for our field, which will in turn advance theories of infant speech perception and provide a foundation for future research including naturalistic studies of neural responses.

P2-D-289 - Links between early prelinguistic communication and later expressive language in infants with autistic and non-autistic siblings

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Details

Autism impacts language and communication skills across the lifespan, and early expressive language skills are highly predictive of long-term social, academic, and vocational success in autistic individuals (e.g., Billstedt et al., 2007). Early prelinguistic communication skills, such as intentional communication, complexity of vocalizations, and responding to joint attention, have been shown to be value-added predictors of later expressive language in autistic children (Yoder et al., 2015). However, the incremental validity of prelinguistic communication skills for predicting later expressive language has not been investigated in younger siblings of autistic children (i.e., Sibs-autism), who have an increased likelihood of receiving a future autism diagnosis and/or language impairment themselves. The present study explored the extent to which early prelinguistic communication skills predict later language in Sibs-autism and infant siblings at population-level likelihood for autism (Sibs-NA).

Participants were 51 infants (29 Sibs-autism, 22 Sibs-NA) aged 12-18 months at the first visit in the study (Time 1). Infants were seen again 9 months later (Time 2). Three prelinguistic communication skills (i.e., intentional communication, vocalization complexity, and responding to joint attention) were measured at Time 1 via observational coding of the Communication and Symbolic Behavior Scales Developmental Profile - Behavior Sample (CSBS; Wetherby & Prizant, 2002). An expressive language aggregate was derived for each participant at Time 2 via the Mullen Scales of Early Learning (Mullen, 1995), the Vineland Adaptive Behavior Scales (Sparrow et al., 2005), the MacArthur-Bates Communicative Development Inventories: Words and Sentences Checklist (Fenson et al., 2007), and the mean length of utterance and number of different words transcribed from the CSBS. Correlation and multiple regression models were run to evaluate associations of interest between prelinguistic communication skills measured at Time 1 and expressive language measured at Time 2.

Intentional communication (r = .537, p = .001) and vocalization complexity (r = .375, p = .007) displayed significant zero-order correlations with expressive language across sibling groups, whereas responding to joint attention did not (r = .257, p = .069). In the full model predicting later expressive language from all three prelinguistic variables across groups, only intentional communication was a significant unique predictor of later expressive language (β = 0.41, p = .006; see Figure), and this model did not significantly improve upon the model that only included intentional communication (p for change in R^2= .24). Sibling group moderated the association between vocalization complexity and later expressive language (p value for group*vocalization complexity = .007); the association was significant in Sibs-NA (r = .600, p = .003) but not in Sibs-autism (r = –.126, p = .52).

Results indicate that prelinguistic communication skills, particularly intentional communication, show promise for predicting later expressive language in infant siblings of autistic children. These findings provide additional empirical support for the notion that early pre-emptive interventions targeting prelinguistic communication skills, especially intentional communication, may have the potential to scaffold language acquisition and support more optimal language outcomes in this population at high likelihood for a future diagnosis of both autism and language disorder.

P2-D-290 - Does IDS input predict IDS preferences at 8 months?

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Details

Infants' preferences for infant-directed speech (IDS) have been well-documented in the literature (see ManyBabies Consortium, 2020). Although there is general agreement that these early preferences, driven by the enhanced prosodic properties of IDS, may facilitate language learning (refs, but see McMurray), the factors that drive individual differences in IDS preferences are less understood. Studies with infants with hearing loss suggest that caregiver use of IDS may be tailored to infants' developing language skills (B reference). Further, infants with hearing impairment have been shown to prefer IDS for longer than their age-matched typically-developing peers (Roberstson et al., 2018). Combined these findings suggest that IDS preferences might be influenced by the proportion of IDS infants hear in their environment. In the current study, we tested this relationship by collecting IDS preference data and language input data from 33 typically-developing monolingual English-learning 8-month-olds (18 males, 15 females). Infants' IDS preference was tested in the lab using a head-turn preference procedure and the stimuli and methodology outlined in the ManyBabies1 project (ManyBabies Consortium, 2020). To capture the proportion of IDS in infants' natural language environment, following their lab visit, families were sent home with a LENA speech pedometer; families were asked to record two 8-hour sessions on two consecutive days. Using methods adapted from Ramirez-Esparza et al. (2014) and Lany and Shoaib (2020), 40 five-minute segments with the highest adult word count (i.e., >110 words) were selected from each 8-hour LENA recording session. From each 5-minute segment, the first 30-second clip that contained speech to the infant was coded. The proportion of IDS was calculated by dividing the number of 30-second segments that contained IDS by the number of segments with adult-directed speech (ADS) plus the number of segments with IDS. Consistent with the extant literature, infants listened significantly longer to IDS (M = 10.59 sec; SD = 3.79) than ADS (M = 9.62; SD = 3.37), $t(32) = 2.70$, $p = .01$, $d = .469$). Although the predicted group effect was observed, there was considerable variability in the degree to which infants preferred IDS. Preliminary data also suggests considerable variability in the proportion of IDS heard by our participants, with a mean of approximately 60%. The remaining LENA data, which has already been collected, is currently being coded. By examining the relationship between infants' IDS preferences and the proportion IDS in their environment, the current data promise to enhance our understanding of the evolving role that parent speech type plays in the development of these ecologically relevant speech preferences. The relevance of the dynamic interplay between infants' emerging language skills and caregiver responding, especially in infants at risk for developmental delays, will be discussed.

P2-D-291 - Examining lexical development of multilingual children in rural Ghana using an adapted vocabulary checklist

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Details

We examined trends in the lexical development of children aged 14- to 26-months in rural Ghana (n=770) using a novel vocabulary checklist adapted from the CDI Words and Gestures short form with

assistance from local consultants in Accra (Fenson et al., 2000). The measure was designed to assess the downstream impacts of parental secondary education on children's language development (Duflo et al., 2023). Children's primary caregivers were read a list of 88 vocabulary items in their native language and asked to indicate which items their children said. Most children were spoken to in a dialect of Akan (84%) and had exposure to at least one other language (54%), most commonly English. Primary caregivers' education ranged from 0-14 years (mean 10 years).

We focused our assessment on three areas. First, we assessed the reliability of our measure by checking its internal consistency, as well as the effectiveness of individual items at distinguishing high- and low-vocabulary children. Second, we examined the effects of age, gender, and parental education on vocabulary outcomes. Finally, we looked for changes in children's vocabulary composition at different points in development that have been observed cross-linguistically (Braginsky et al., 2019). For each of our analyses, we compared our results from Ghana to data from a sample of monolingual English-speaking children (16- to 25-months) from upper-middle class American households who were given the Words and Gestures form obtained through Wordbank (n=645) (Walle & Campos, 2014; Frank, et al., 2016).

For both groups, we found evidence of high internal consistency in caregiver responses for both measures (Cronbach's alpha > 0.98). In Ghana, we found that vocabulary items related to kinship terms, sounds, and social routines were not effective at distinguishing children by ability, whereas in America poorly performing items were spread across many different categories (e.g., "finish", "candy", "fast", "leg"). Across groups, vocabulary increased with age, and girls had slightly larger vocabularies on average. However, we found no effect of caregiver education in either group. Children in the American sample had slightly higher vocabularies, on average, and multilingual children in Ghana had larger vocabularies than monolingual children.

Finally, we found similar shifts in vocabulary composition for both groups throughout development (see Fig. 1 & 2). Children with lower vocabularies tended to know more social words (e.g., sounds, people, routines). Children with higher vocabularies tended to know more predicates (e.g., adjectives and verbs) and closed class items (e.g., question words, pronouns, time words). Among children with lower vocabularies, knowing more nouns was positively associated with vocabulary size, but negatively associated in children with larger vocabularies. Each of these trends were found to be smaller in magnitude in the Ghanaian sample than in the American English sample.

Our study suggests that children's vocabulary growth follows similar trends in Ghana as in America. Our assessment also suggests our measure is comparable to the American English shortform in reliability, with some differences in item performance. Finally, children in highly multilingual countries like Ghana may exhibit larger vocabularies when their total language exposure is considered.

P2-D-292 - Title: auditory and language development: Exploratory Study with the International Classification of Functioning, Disability, and Health

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Details

Introduction: The auditory development is a process that occurs in various stages. Disruption in any of these phases, but especially in the early stages, can lead to significant functional impairments in a child's development. Therefore, there is a need to identify hearing impairment within the first month of life and the indicators of risk for hearing impairment. The International Classification of Functioning, Disability, and Health (ICF) was created with a biopsychosocial perspective to understand in detail all interactions, social determinants, and contextual factors in an individual's health condition. This is a data collection instrument that assists in the analysis of the population and allows for the development of appropriate assessments, monitoring, and interventions.

Objectives: Describing the auditory and language development of prematurely born children undergoing follow-up care in an outpatient clinic, based on information provided by parents, and considering the perspective of the International Classification of Functioning, Disability, and Health

Methods: This is an observational, descriptive, and cross-sectional. The study received approval from the institution's research ethics committee. The sample consisted of 94 patient records of children corrected aged 1 to 12 months, born between June 2021 and March 2023. An anamnesis was conducted, addressing three main axes: a) sociodemographic data, encompassing family profile, household income, and housing-related issues; b) clinical data, comprising information about the gestational period and potential complications in the prenatal, perinatal, and postnatal periods; c) healthcare aspects, involving access to healthcare services and the performance of neonatal screenings. Additionally, medical records were analyzed to identify clinical data, healthcare aspects that could indicate risks for auditory development and Universal Neonatal Hearing Screening (UNHS) results. The questionnaire for monitoring auditory and language development in the first year of life (Bernardi et al, 2017) , based on the ICF, was administered through an interview. The questionnaire comprises 22 questions, and the ICF categories related to auditory, speech, and language functions according to developmental milestones expected for the age group. Responses follow the ICF proposed standard, with 0 indicating no impairment or normal capacity and 8 indicating the presence of impairment or incapacity, without specifying the degree.

Results: Among the 94 records examined, only 71 contained comprehensive data, there is an inadequate completion of approximately 24%. Tables 1 and 2 provide descriptive results for risk factors, auditory assessment, and the questionnaire monitoring auditory and language development. It is worth noting that the questions regarding linguistic development at nine months indicated delays of approximately 25% and 35%.

Conclusion: Our results showed that language development questions were the ones parents perceived more delays, particularly in the CIF categories related to Non-speech vocal expression and Communicating with - receiving - simple spoken messages.

P2-D-293 - The consonant-bias is influenced by syllabic position in a familiar word recognition conflict task, a cross-linguistic study of German- and French-learning toddlers.

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Details

Nespor et al. (2003) proposed that consonants and vowels carry different functions in language processing, vowels being more important for prosodic/syntactic processes and consonants for lexical processes. The consonant-bias in lexical processing (C-bias) is supported by adult/infant studies in several languages including English and French, although cross-linguistic variations exist, with an early C-bias in French, but later C-bias in English, and little published evidence for German (Nazzi & Cutler, 2020, for a review). Here, we investigate whether a C-bias in word recognition would be found in both French (C-bias expected) and German (C-bias might emerge later, due to language-specific properties) toddlers.

For this, French-learning (N=32) and German-learning (N=30) 24-month-olds were tested with a preferential-looking experiment investigating the C-bias during lexical access, with a task introducing a conflict between consonantal and vocalic information. The experiment tested word recognition when presenting on a screen two different familiar objects. In the control condition, the target word corresponded to one of the objects presented, while in the conflict condition, the target differed from one of the objects by a consonant and from the other by a vowel, the C-bias predicting that the consonant difference should matter more. Because of potential positional effects modulating the C-bias (Havy et al., 2014; Floccia et al., 2014), half of the C-mispronunciations were in syllable onset (e.g., French auditory nonword /tys/, is onset C-mispronunciation of /bys/ "*bus*" and V-mispronunciation of /tas/ *"mug"*; n=8 trials), and the other half in syllable coda (e.g., French auditory nonword /suʒ/, is coda C-mispronunciation of /sup/"*soup*" and V-mispronunciation of /sɛ̃ʒ/*"monkey"*; n=8 trials).

Separate analyses were performed in each language group. In the control condition, window analyses showed that each group correctly recognized familiar words (*p*s < .001; Figure1), indicating that the task was age-appropriate. In the conflict condition, window analyses failed to reveal an overall C-bias (*p*s > .19). However, time-course analyses showed significant time-dependent processing differences between the two types of conflict trials for both groups (Figure2). For the German-learning group, results revealed that toddlers' target-looking to the two types of conflict trials differed significantly between 3700ms and 4300ms (*p*=.04): toddlers looked more at the C-mispronounced object (e.g., at /tyːr/ rather than /bɛːr/ when hearing /byːr/) when the mispronounced consonant was in onset position, while they looked more at the V-mispronounced object (e.g., /ball/ rather than /bett/ when hearing /bell/) when the mispronounced consonant was in coda position. For the French-learning group, the results revealed that toddlers' target-looking for the two trial types followed different linear (*p*=.001) and quadratic (*p*<.001) time trajectories.

This study first shows clear word recognition. No clear evidence of a C-bias was found, possibly due to difficulties in processing in parallel the visual objects and close mispronunciations of their labels. Yet, the results show clear crosslinguistic differences in how relative position of the C-misps impacted performance, which we will discuss in terms of interaction between the C-bias and other phonological processes.

P2-D-294 - Dyadic variance predominates in infants' vocalizations

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Details

Developmental theorists emphasize the role of dyadic processes in language development and empirical research has focused on the interaction of caregiver-infant dyads in home settings. Studying caregiver-infant dyads, however, does not readily allow us to tease apart dyadic from individual processes. Early care and preschool classrooms are one understudied naturalistic developmental context in which the same infant participates in many dyadic interactions with different partners. Infants' vocalizations could be primarily a factor of who is vocalizing (focal infant variance), who they were vocalizing to (partner infant variance), or dyadic variance (the interaction of focal infant and partner). Moreover, levels of vocalizations might also vary by classroom and observation date. Here, we disentangled these sources of variance using objectively measured peer speech in preschool classrooms.

Participants included 37 infants (19 girls; *M*=31.03 months) enrolled in 8 classrooms. Twenty-one were Hispanic/Latinx (20 White, 1 multiracial); 16 were not Hispanic/Latinx (10 White, 4 Black, 2 Asian). During monthly school-day-long observations (n=48; *M*=5 per class, SD=4), infants wore lightweight vests equipped with Language ENvironment Analysis (LENA) recorders to measure vocalizations and Ubisense Radiofrequency Identification tags to measure location. Vocalization and location data were synchronized to determine each infant's vocalizations to and from each of their peers while in social contact (determined by proximity and orientation). All infants were included as both focal infants and partners. Each dyad was given a unique dyad identifier such that e.g., Infant A and Infant B were always Dyad 1 both when A was talking to B and B was talking to A.

A linear mixed effects model predicted the rate of vocalizations each infant made to each of their peers. The model included random intercepts of focal infant, partner, dyad, classroom, and observation date. Fixed effects were not included to focus on variance in vocalizations associated with random effects, calculated as interclass correlations (ICCs). As can be seen in Figure 1, the dyad effect accounted for the most variance, ICC=.43, SD=14.22, 95% CI (12.06, 16.24); followed by classroom, ICC=.10, SD=6.75, 95% CI (.52, 13.71); date, ICC=.05, SD=4.99, 95% CI(3.63, 6.98); and focal infant, ICC=.02, SD=3.43, 95% CI(1.99, 5.33). The partner effect did not account for any variance. Model comparison revealed inclusion of dyad, classroom, date, and focal infant intercepts significantly improved the model *ps*<.00001, but inclusion of partner intercept did not, *p*>.99, when the other intercepts were included. Figure 2 shows example data from 9 dyads in 1 classroom including the same infant.

Results indicate variation in infants' vocalizations at both the dyadic and the individual level. At the individual level, some infants vocalize more to their partners than others, a reflection of individual differences in sociality. However, there was no evidence that some infants were preferred over others as *recipients* of this speech. Instead, dyadic variance was the largest contributor to differences in infants' vocalizations indicating that dyadic interactions are more than the sum of their parts.

P2-D-295 - A longitudinal study of caregiver song and speech and infant vocalizations sampled from daylong recordings

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Details

Language development and music exposure have been found to be positively associated as early as preschool age: music training appears to be beneficial for skills related to language learning such as phonological processing (Anvari et al., 2002) and speech discrimination in noise (Strait et al., 2013) while language learning has been shown to assist in music perception to some degree (Politimou et al., 2019). Although most studies have focused on children aged 3+ years old, a study using daylong infant-centered recordings found that a positive association between overall music input at the day level and turn-taking, a type of pre-linguistic experience, is apparent for 6–12-month-olds (Edgar & Fausey, 2019). However, experimental work has found that musical stimuli can also lead to shorter infant vocal bursts than speech stimuli (Reigado et al., 2011). It is thus an open question whether musical input from caregivers in naturalistic contexts leads to bursts or lulls in infant vocalizations. In this study, we take steps toward addressing this question by analyzing 5-minute clips from daylong infant-centered audio recordings to examine whether there is a correlation at the 5-minute level between infant-directed singing by caregivers and infant vocalization behavior.

413 five-minute high infant vocal activity sections drawn from longitudinal day-long recordings of 54 infants at ages 3, 6, 9, and 18 months were hand-coded to identify onsets and offsets of vocalizations by the target infant and by adult caregivers. Non-vegetative infant vocalizations were classified into four mutually exclusive and exhaustive categories: canonical (C), non-canonical (X), cry (R), and laugh (L). Adult vocalizations were categorized by addressee (directed towards the infant (T) not directed towards the infant (N), and unknown (U)) and by musicality (non-musical (NM), lyrical singing (LL), and non-lyrical singing(NL)). Fig. 1 shows the prevalence of vocal types at different ages. To test for potential associations between infant and caregiver vocalizations of different types, we ran a linear mixed effects model to predict the logged total duration of each of the infant vocalization types with the quantities of each adult vocalization type as fixed effects. Infant age was an additional fixed effect and infant ID was used as a random effect.

Results are in Table 1. Focusing on musical adult vocalizations, total duration of lyrical adult vocalization input (i.e. singing) was negatively associated with total duration non-canonical vocalizations ($\beta = -0.17$, $p = .004$) and non-lyrical musical adult input was negatively associated with canonical infant vocalizations ($\beta = -0.18$, $p = .048$). These results suggest that musical vocal input from caregivers either is not prompted by or does not particularly elicit infant speech-related vocalizations at a relatively shorter timescale within the day. Associations between turn-taking rates and musical input found in prior studies may be due to other underlying factors such as overall mood and engagement. Future work should analyze immediate temporal contingencies (i.e. leading-following relationships) between these adult and infant vocalization types, as well as explore different types of musical input (e.g., soothing lullaby versus stimulating play songs).

P2-D-296 - A comparative study of the Bouba-Kiki effect: evidence from three-day-old domestic chicks

Maria Loconsole [1], **Silvia Benavides-Varela** [1], **Lucia Regolin** [1]

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Details

If you hear the non-words “Kiki” and “Bouba”, you may be more likely to associate them with a spiky and a round object, respectively, rather than the opposite. This is a case of sound-symbolism, and it is known as the Bouba-Kiki effect. Based on evidence from 4- to 7-month-old preverbal infants, some authors suggested that the Bouba-Kiki effect might constitute a predisposed perceptual mechanism. Yet, these studies were not conclusive, as they failed to completely rule out a fast experience-driven origin of the effect resulting from infants’ speed of learning, their high sensitivity to environmental statistical regularities, and the large number of sound-symbolic associations to which they are exposed when interacting with adults. To better describe the ontogeny of the Bouba-Kiki effect and fill in this gap we tested young domestic chicks for their spontaneous preference to associate shapes and sounds. Human infants and domestic chicks are known to share analogous predisposed cognitive and perceptual mechanisms, however, being a precocial species chicks can be tested already on the very early days of life, allowing for a virtually total control of their experience from the moment of hatch to test. In our study, three-days-old chicks (Gallus gallus) first learned to circumnavigate a panel to obtain a food reward. Then, they were presented with two identical panels, one depicting a spiky shape, and one depicting a round shape, while hearing the sound “Bouba” or “Kiki”. We recorded which panel chicks chose with either sound, in a total of 24 trials. Evidence of sound-symbolism in chicks would emerge as a preferential approach of the spiky shape when hearing the “Kiki” sound, and of the round shape when hearing the “Bouba” sound. Preliminary data obtained from 26 subjects support our hypothesis. When hearing the “Bouba” sound chicks were less likely to approach the spiky shape ($P(spiky) = 0.24$, $SE = 0.03$, $z = -6.97$, $p < 0.0001$). In contrary, they had a higher chance to choose the spiky shape when hearing the sound “Kiki” ($P(spiky) = 0.6$, $SE = 0.03$, $z = 2.97$, $p < 0.01$). Overall, our results hints at a predisposed mechanism for matching the two dimensions of shape and sound. Moreover, evidence from a non-human animal suggests that such a mechanism might be widespread across species.

P2-D-297 - From cooing to words: the stages of infant speech production development revisited

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Details

Language development in infants has received a fair amount attention. However, most of these studies focus on the cognitive mechanisms and environmental factors supporting infants’ language comprehension only. Very little research addresses speech production development at this age. The currently established view is that between 3 and 18 months of age infants go through the stages of producing cooing (strings of vowels; single syllables) babbling (reduplicated, variegated), protowords, and then words in a linear fashion. In the current study, we took a critical look at this linear stepwise developmental trajectory of early speech production development.

We collected video recordings from 62 infants (40% females) between 3 and 18 months of age. Infants came from a diverse linguistic background (56% monolingual English; 44% bilinguals/multilingual). Our bilingual sample was heterogenous; in addition to English, infants learnt a variety of different languages, including French, Spanish, Cantonese, Mandarin, Russian, Korean, Hindi, Yiddish, Farsi, Italian, Malayan, and Sinhalese. Each infant contributed 1-3 videos that were at least 7 minutes in duration (107 videos in total). The videos were recorded by the caregivers during developmentally appropriate unstructured play or interactions. Videos were coded using a video annotation software (ELAN, Sloetjes & Wittenburg, 2008). The following predetermined vocalization categories were coded in each video: string (mostly vowels with potentially some early consonants intermingled; e.g., 'aaamaaa'); single syllable (single consonant vowel; e.g., 'ma'); reduplicated (repetitive consonant vowel; e.g., 'mamama'); variegated (consonant vowel sequences with a variety of consonant and vowel sounds; e.g., batatetoo); protowords/words (symbolic function of production is clear); and other (e.g., sneeze, cough, etc). Each video was coded by at least two coders. Inter-coder reliability was at least .85.

We used mixed methodology to analyze the obtained data set. From a qualitative perspective, we turned to the Grounded Theory framework (Dunne, 2011; Tie, Birks & Francis, 2019). Within this framework, in consultation with our coders, we evaluated to what degree the aforementioned vocalization categories are meaningful when early speech productions are considered in the analyzed videos. In terms of a quantitative perspective, we measured the frequency of vocalization categories across age. Our preliminary findings suggest that categorizing early vocalizations is not straightforward. Many productions do not fit the commonly used categories. This is partially because infants also produce a substantial amount of early type of vocalizations (e.g., babbling) at later stages of development (e.g., after 12 months of age), which makes the interpretation of the vocalization types problematic. Overall, productions seem to follow the currently established linear pattern of development in terms of levels, however they do not seem to be so differentiated, but are more overlapping and iterative in their nature. Implications of these observations on the current stepwise view of speech production development will be discussed.

P2-D-298 - Different neural activity in response to consonant- than vowel-mispronunciations in French-learning infants in a word recognition task

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Details

According to the "division of labor" (Nespor et al., 2003), the role of consonants and vowels in language processing differs, with consonants more implicated in lexical processing and vowels in rhythmic/syntactic processing. In tasks where lexical encoding is necessary, consonants have been shown to play a more important role (C-bias) in several languages, including French, and as early as 8 months of age (Nazzi & Cutler, 2019). Neural-based evidence for this division is scarce, both in adults (e.g., Carreiras et al., 2009) and infants (Von Holzen et al., 2018). Von Holzen et al. (2018) tested French-learning 8-month-olds' sensitivity to segmented mispronounced words: ERPs showed a weak C-bias for "negative-responders",

interpreted as neurally more mature. Here, we investigate the C-bias in older infants, and in a familiar word recognition task based on Mani et al. (2012). In that audiovisual EEG study, English-learning 14-month-olds recognized familiar words, and detected vowel mispronunciations of these words (consonant mispronunciations were not tested). Using a similar paradigm, the present study recorded the EEG of French-learning 18-month-olds during word recognition of (1) correctly pronounced familiar words (CP), (2) consonant- (C-misp) and (3) vowel-mispronunciations of these words (V-misp), and (4) pseudowords (PW).

Twenty-two French-learning 18-month-olds were included in the final sample. Stimuli were 32 quadruplets each made up of a familiar disyllabic word (e.g., *banane*), a first consonant mispronunciation (e.g., *danane*), a first vowel mispronunciation (e.g. *bénane*), and an unrelated pseudoword (e.g., *chobrain*). For each quadruplet, four representative images were used and counterbalanced across conditions/infants. EEG was recorded from a 128-channel HydroCel EGI net (sampling at 250Hz) while infants first saw each image and heard 750-1250ms later either the CP, C-misp, V-misp or PW (total of 128 trials).

Preprocessing (filtering 0.1-30Hz, -100 to 650 ms baseline-corrected segmentation, artifact rejection/correction) of the EEG data was conducted in MATLAB using fieldtrip. Words unknown to each infant (based on familiarity scores from parents) were removed from the analysis. Cluster-based permutation tests (Monte-Carlo based randomization) revealed differences between 300 to 600 ms in the following conditions: CP versus PW, with a more positive brain response to CP in a right frontal cluster (Figure 1a); CP versus C-misp, with more negative amplitudes to CP in a left parietal cluster (Figure 1b); CP versus V-misp with more negative amplitudes to CP in a left parietal cluster (Figure 1c); and C-misp versus V-misp with more positive signal to C-misp in a left posterior-parietal cluster (Figure 1d). These findings establish that, firstly, our 18-month-olds know and recognize our test words (as in Mani et al., 2012, with CP exhibiting a more positive brain response). Secondly, they reveal that the infants detect both consonant and vowel mispronunciations of the words (our clusters aligning with the left-temporal ROIs in Mani et al. as well as their later epoch, 400-600ms), while also establishing an earlier-in-time difference in response between the processing of consonant and vowel mispronunciations, opening the way for a more optimal way of exploring the effect of the C-bias in the future.

P2-D-299 - Embodied verb learning: Adult perceptions of infants' verb learning opportunities

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Details

Learning verbs is a tall order for infants. Unlike learning nouns where the referent is a physical object, learning verbs requires infants to map the word to a temporary event or action. Embodied theories of verb learning propose that infants' motor actions are powerful cues to deciphering verb meanings. Caregivers closely tailor their verb input to infants' real-time actions (e.g., caregiver says "kick the ball" while infant kicks around a ball). However, it is unknown whether the action-verb correspondence is indeed helpful for verb mapping. Here, we use adult raters to quantify whether particular verb learning moments (those that align with infant actions) are more supportive of verb learning than other moments.

Here, *N* = 200 adult raters watched 24 6-second video clips of caregiver-infant interactions in which the caregiver said an action verb. In each clip, the verb is omitted with a tone (e.g., *"close the lid"* is heard as *"_____ the lid"*). The clips were taken from real, naturalistic recordings of infants at home (West et al., 2022). For half the trials, the verb corresponded to the infants' simultaneous action; the other half did not. Half of the verbs referenced whole-body actions (e.g., "jump", "climb"), half referenced manual verbs (e.g., "press", "clap"). Half of the verbs were transitive (referencing an object, like "press the button"); half were intransitive (the did not reference an object, like "clap clap!"). Upon viewing each clip, the adult raters guessed the omitted verb from a menu of three choices: the correct verb and two competing verbs.

Results show that alignment between verb and infant action indeed facilitated verb mapping. Figure 1 shows the average percentage of correct guesses for verbs that were aligned (pink bars) and unaligned to infant actions (green bars). Across every verb type, adult raters were better at guessing the correct verb when the verb was aligned with the infants' actions in the clip (*Ms* = 84.17% and 83.33% for whole-body and manual verbs respectively; *SDs* = 15.17, 16.17) compared to when the verb was not aligned the infants action in the clip (*Ms* = 61.0% and 61.33% for whole-body and manual verbs respectively; *SDs* = 17.5, 20.83). Interestingly, adult raters were overall better at guessing intransitive verbs (e.g., "are you waving?") compared to transitive verbs (e.g., "you closed the lid").

A growing literature finds real-time connections between infants' actions and their word learning opportunities. In particular, studies highlight a possible behavioral cascade wherein: (1) caregivers tailor their verbs to infant actions, and in turn, (2) the infants' action serves as a salient clue to the verb's meaning. Although the literature is replete with studies showing that indeed, caregivers sync their words with infant actions, the second part of the cascade is untested. Our study uses an experimental design leveraging adult raters to demonstrate that infants' actions can serve as exceptionally powerful indicators of a spoken verb's meaning.

P2-D-300 - Evaluating dimensions of early communication among Spanish-English learning toddlers with and without language delays

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Details

Introduction

Although Spanish is the second most spoken language in the US (US Census, 2022), there remain gaps in understanding early language development and delay (LD) in this population. Vocabulary size is a common marker of LD, but other measures offer promise for improving detection of LD (e.g., Perry et al., 2022). Of interest in the present study are measures of (a) lexical breadth (vocabulary size), (b) semantic organization, and (c) communication rate among toddlers exposed primarily to Spanish and their association with (d) expressive language. We asked: What are the correlations among measures at 24 and 30 months of age? How do children with and without LD differ? How well do measures at 24 months predict expressive language at 30 months compared to vocabulary size alone?

Method

Children with and without LD participated at 24 (n = 68) and 30 (n = 71) months of age. Children with parental concerns about language development or who were receiving Early Intervention for communication made up the LD group. Children were primarily exposed to Spanish relative to English. Child data was collected via parent report of words spoken on the English-Spanish Vocabulary Inventory (ESVI; De Anda et al., 2016) and observed child language use during a 10-minute mother-child free-play sample.

Lexical breadth was operationalized as total conceptual vocabulary (words spoken in Spanish or English) and semantic organization as the number of categories with <= 4 words spoken from the ESVI (e.g., Kover et al., 2018). Communication rate was the count of all intentional communicative attempts during free-play, including verbalizations and vocalizations. Expressive language included: Mean Length of utterance in Words (MLUw), Number of Different Words (NDW), and Sentence Diversity (SD: the number of unique subject-verb combinations).

Results

The correlations across ages suggest breadth, rate, and semantic organization are differentially correlated with concurrent expressive language as captured by MLUw, NDW, and SD (Table 1). Specifically, whereas associations between vocabulary size and expressive language measures are consistent across 24 and 30 months, semantic organization appears to capture separate variance. Moreover, t-tests showed significant differences between toddlers with and without LD at 24 (all p's < .03) on the measures of interest, but not at 30 months.

Regarding prediction, results suggest that together measures of breadth, rate, and semantics at 24 months explain significantly more variance in NDW (R^2= 0.85 vs. 0.59 respectively; $\chi^2(4)$ =15.39, p = .004) and MLUw at 30 months (R^2 = 0.55 vs. 0.19 respectively; $\chi^2(6)$ =15.48, p = .02) than vocabulary size alone. Additional coding of SD is underway to permit similar model comparison by the time of the conference.

Conclusion

Results suggest that measures beyond lexical breadth (vocabulary size) can predict expressive language outcomes among Spanish-English bilingual toddlers with and without LD. Measures of breadth, rate, and semantic organization are relatively efficient to collect and available to measure well before the emergence of word combinations. Together this work may increase detection on individual variability in expressive language development before age three.

P2-D-301 - Investigating the convergence of child language assessment measures in 14-month-old Korean infants

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Details

This study investigates convergence between parental reports and empirical word comprehension measures in 14-month-old Korean infants, using eye-tracking and the Korean version of the MacArthur-Bates Communicative Development Inventories (MCDI-K). We aimed to contribute to the ongoing debate over the reliability of parental reports in assessing language comprehension, especially in preverbal infants. Parental reports, while practical and comprehensive, often rely on subjective inference, has prompted concerns about their accuracy, especially in preverbal stages. We sought to provide an objective comparison using eye-tracking measures as a benchmark. Despite eye-tracking's challenges, such as infants' shifting attention and stimulus biases, we took an integrated approach to provide a balanced view of language development assessment.

We conducted an eye-tracking word recognition test with 25 Korean infants (around 14 months old). They were exposed to 40 target words presented in yoked pairs, and their gaze responses were recorded and analysed. Concurrently, parents completed both the full and a short version of the MCDI-K, with the short version focusing on the target words used in the eye-tracking test. We utilised four gaze metrics to measure word recognition: raw proportion of looking time to the target, increase in looking time for the target versus a distractor, change in looking time from baseline to target presentation, and a combined metric adjusting for image bias and baseline attention. These metrics, excluding raw proportion, aim to isolate word recognition from biases, with positive values indicating recognition. The correlation analysis (Figure 1) revealed a significant correlation between infants' word recognition performance and the short version of the CDI, but not with the full version or the CDI percentile.

We assessed alignment between parental reports and infants' word recognition, examining both positive and negative alignments against non-alignments (positive or negative from both perspectives of measure). Alignment calculations were based on concurrence between parental reports and gaze metrics. This objective method, which does not treat one data set as the ‘truth’, contrasts with traditional metrics like F1-score or accuracy. This method also deviates from group-centric analyses like correlation, enabling more granular, individual-level validation. Non-alignment, therefore, could indicate either limitations in gaze metrics or inaccuracies in parental reporting. Ratios were computed by dividing the number of matches in positives or matches in negatives by the total number of corresponding alignments and non-alignments. A robust alignment exceeds a .3 chance level.

Our findings (Figure 2) suggests a tendency for higher positive alignment in word recognition, reflecting a reliable match between parental reports and eye-tracking data when infants recognize words. However, overall low negative alignments suggest uncertainties in detecting when infants do not recognize words. This discrepancy invites future research to investigate the causes – whether they stem

from the limitations of eye-tracking in capturing infants' gaze preference or from inaccuracies in parental reports.

In conclusion, our research underscores the importance for multi-method approaches in child language research, e.g., combining parental reports with eye-tracking data for a more precise view of early language development.

P2-D-302 - Joint attention and exogenous attention allocation during mother-infant interaction at 12 months associate with 24-month vocabulary composition

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Details

Rationale. The transition to the third year of life represents a pivotal turning point for language development. Children's vocabulary tends to experience a significant increase at the end of the second year of life and many children start to combine different words. This phase is often accompanied by a sensible increase in predicates production. Individual differences in language development have been meant to be partly linked with infants' exogenous attention allocation guided by environmental inputs (e.g., sounds) and endogenous contributions of infants' capacity for joint attention to a third object (e.g., gaze triangulation). Nonetheless, the conjoint role of these potential contributors is yet to be examined. **Goal.** In the present study, we assessed how early forms of attention at 12 months (i.e., exogenous attention allocation and joint attention initiation) might modulate individual differences in 24 months language development in typically developing children. **Methods.** At 12-month-age, 46 mothers and infants participated in a video-recorded face-to-face interaction via teleconferencing. The procedure comprised five consecutive episodes: an initial two-minute face-to-face interaction without restrictions, followed by a stimulation episode where researchers played a series of three sounds. These sounds included social stimuli such as a friendly "hello" and an affectionate "how nice," as well as non-social stimuli, such as the sound of flowing water and a mixer noise (Figure 1). The interaction was coded for the direction of infants' Gaze Orientation (GO) – to the mother or to the sound source – and a time percentage for each gaze direction was obtained for each task episode. At 24 -month age of children, the mothers filled in an Italian adaptation of the McArthur Bates Communication Development Inventory (CDI) short form. Composition percentages were computed for the four word-categories: social, nouns, predicates, and closed class words. **Results. Con**firming previous findings, we observed significant positive associations between the total vocabulary size (number of words produced) and percentage of nouns, $r(44) = .350$, $p = .017$ and predicates, $r(44) = .878$, $p < .001$ (Figure 2A). Main results showed significant negative associations between exogenous attention allocation and later vocabulary composition (i.e., percentage of predicates), $r(44) = -.342$, $p = .020$. This association was further modulated by joint attention initiation, $\beta = .258$, $t(43) = 2.03$, $p = .049$. Single-slop analyses revealed that only infants displaying higher levels of triangulation showed a significant negative association between exogenous attention allocation and language development (Figure 2B). **Discussion.** The present study expands our knowledge of early developmental cascades in language acquisition and might support the current literature on potential targets for screening and intervention.

Figure 1. Graphical representation of the interactive task at 12-month-age.

Figure 2. A, word-categories distribution; B, interactive effect of exogenous attention allocation and initiation of joint attention on predicates production.

P2-D-303 - Reading vs watching: How socially contingent interactions differentially support word learning across modalities

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Details

Socially contingent interactions, where social partners are responsive and timely in communication, play a critical role in early language acquisition (Roseberry et al., 2013; Troseth et al., 2006). These interactions offer opportunities for caregivers to label objects during every-day interactions, allowing infants to then integrate the labels into their vocabulary (Clerkin & Smith, 2019). Such interactions often occur during joint book-reading, when caregivers pose questions, repeat information, and elaborate on the text, ultimately providing supplemental talk known to support learning (Sénéchal, 1997). Children are also increasingly engaging with caregivers in tech-based activities such as co-viewing of videos (Rideout & Robb, 2020). Yet little work has asked whether and how socially contingent interactions support word learning in these contexts. Though some evidence shows caregiver-mediated viewing of video may enhance learning (Strouse et al., 2013), no research has directly compared how socially contingent interactions impact learning from books and video.

To address this gap, 52 infants (30-36 months) were exposed to four novel noun-object pairs in a lab-created story in one of two modalities: a printed storybook (read by parents) or video (narrated by the first author, with text removed and small animations added). Dyads were randomly assigned to be socially-contingent (instructed to talk and elaborate upon the content), or non-contingent (asked to refrain from additional engagement). Following story exposure, infants' word learning was tested using a two-alternative forced choice pointing task. Parents completed the MacArthur-Bates Communicative Development Inventory-III (MBCDI-III; Fenson et al., 2006) as a measure of productive vocabulary.

First, social contingency during training was examined. A 2x2 ANCOVA controlling for vocabulary revealed a main effect of social contingency on caregiver's repetition of the target words, $F(1,49)=24.810$, $p<.001$ but no effect of modality, $F(1,49)=.312$, $p=.373$ or interaction, $F(1,49)=.376$, $p=.328$. Caregivers instructed to be socially engaged provided more supplemental talk across both books and videos. Critically, children in turn increased their own repetitions of words - caregiver repetitions correlated positively with child repetitions, $r(50) = .808$, $p<.001$ (Figure 1), resulting in children talking more in the socially contingent condition, $F(1,49)=3.975$, $p<.001$, but equally across modalities, $F(1,49)=.267$, $p=.205$.

Second, children's learning in each contingency condition and modality was tested. There were no effects of social contingency, $F(1,50)=.101$, $p=.202$, modality, $F(1,50)=.023$, $p=.539$, or interaction, $F(1,50)=.113$, $p=.176$. However, parent repetitions during training did correlate with children's retention,

r(49)=.300, *p*=.036. Moreover, children were able to learn novel words and selected the target object above chance in all conditions (*p*'s <.001) except the non-contingent book condition, *t*(8)=1.33, *p*=.219 (see Figure 2).

Taken together, the results suggest that first, caregivers easily comply with simple directions to be socially contingent and supplement the story significantly across modalities. Second, children's own talk increased when parents' talk did, suggesting that socially-contingent interactions positively impact children's behavior. Finally, children are readily able to learn novel words across most conditions, suggesting learning in a variety of contexts is possible at this age. These findings suggest avenues for supporting caregiver-child interactions for long-term language outcomes in an increasingly digital world.

P2-D-304 - The concurrent effect of contingency on learning novel word-object associations in Japanese and French 13-month-olds

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Details

Human children eventually master their native language perfectly, but the trajectory of language learning may differ greatly across languages and cultures. For example, it has been argued that the ability to learn new words is somewhat delayed among Japanese-learning children when compared with their English-learning peers (Okumura et al., 2016). The explanation for such a difference, however, remains largely unknown.
One prominent factor contributing to language learning is children's awareness and exploits of social cues (e.g., Kuhl, 2007), which can be largely affected by the cultural backgrounds of children. For example, Japanese and British children differ in their face scanning patterns (Haensel et al., 2020; Senju et al., 2013). It is therefore conceivable that differences in the perception of an interaction with the social environment play a role in explaining cross-cultural differences in language learning.
In this study, we focused on the effect of one social cue, namely social contingency, on learning word-object associations. We used a controlled experiment (Figure 1) to systematically test the cross-cultural differences in the contingency effect among Japanese (n = 34) and French (n = 39) 13-month-olds. The manipulation of contingency was achieved by obtaining children's real-time eye-gaze with an eye-tracker and pre-programming the eye-gaze of a virtual agent on the monitor to either mirror the eye movement of the child (contingent) or replay a child's eye movement recorded from a previous experiment (yoked). Each subject was introduced to one novel word-object association in the contingent and another one in the yoked condition. The results of the test phase, analyzed using growth curve modeling (Figure 2), demonstrate that Japanese toddlers achieved better outcomes when learning from a contingent agent ($t = 5.92$, $p < .001$), but French toddlers did not ($t = -7.24$ (learning worse from contingent agent), $p < .001$), although novel word-object associations were not learned reliably overall. One interpretation of these results is that Japanese toddlers at this age benefit more from the presence

of social cues, which have often been absent in lab experiments comparing word learning across cultures.

P2-D-305 - Word-level convergent validity between looking-while-listening and caregiver report measures of vocabulary

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Details

Researchers, clinicians, and caregivers have strong motivations to know which words toddlers understand. However, measuring early word knowledge poses unique challenges. Researchers are limited to indirect measures (caregiver report) or implicit eye-gaze paradigms to measure word comprehension. Because we cannot explicitly measure toddlers' word knowledge, our implicit measures must have high validity to ensure that we are accurately capturing language competencies.

Prior investigations of convergent validity between caregiver report measures and looking-while-listening paradigms (LWL) have been inconclusive. Importantly, the extent to which these two measures converge may depend on the features of each task. Caregivers could consider many language experiences when reporting, while LWL tasks only test infants' word comprehension in the context of a small set of images. In the present study, we examined convergent validity between LWL and caregiver report at the word-level using a more ecologically-valid LWL task.

We tested a set of 8 nouns that varied in age of acquisition. On each trial, toddlers saw two images and heard a noun labeling one of the images. We intentionally included several target referents for each word and paired each word with several distractors to create a robust measure of word comprehension. To measure caregiver report, we modified the MB-CDI (Words & Sentences) to include three levels of word knowledge (i.e., says, understands, and unknown). We also measured caregivers' confidence in their report for each of the words used in the LWL task. We predicted that while convergent validity would be highly variable at the word level, it would increase with increasing levels of caregiver confidence.

Preliminary data visualizations (N=28/52 planned; 15 females; M=18.9 months; SD=0.46; 82% White; 4% Asian; 14% Multiracial) suggest that convergent validity between LWL and caregiver report varies depending on the specific word tested. For example, LWL accuracy is higher for toddlers whose caregiver reported they say the word ball than toddlers who are reported to only comprehend ball (Figure 1). By contrast, toddlers appear to recognize the word apple regardless of caregiver report (Figure 1). Furthermore, alignment between the two measures seems to, in part, depend on caregiver confidence in their reports of vocabulary. As depicted in Figure 2, when caregivers report a high degree of confidence that their child produces a word, their child demonstrates better word recognition accuracy. Similarly, when a caregiver reports high confidence that their child does not understand a word, their child is performing at chance in the LWL task. Confidence, however, seems to influence alignment less strongly for words that caregivers report to be understood (Figure 2). Together, these initial findings suggest that LWL tasks and caregiver report may not always capture the same

information about toddlers' knowledge of individual words. By considering caregivers' certainty in their reports of vocabulary, we may be able to improve the validity of caregiver report measures.

P2-D-306 - Early perceptual discrimination of stop categories: New perspective from data of Thai-, Korean-, and Japanese-learning infants

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Details

Infant research, predominantly with infants learning Indo-European languages, shows that young infants can discriminate a variety of speech stimuli that are not present in their native language environments; an ability which gradually reduces during the first year. This phenomenon is termed perceptual narrowing, an influential view in speech development (Singh et al., 2022).

Aslin et al. (1981) investigated discrimination along the synthesized stop VOT continuum with English-learning infants and reported that infants as young as 6 months were able to discriminate negative and positive VOTs, with greater sensitivity in the positive region, boundaries existing in their native and in non-native languages such as Thai. In fact, language-general VOT sensitivity boundaries have been proposed to lie between -30 and +30 ms (Hoonhorst et al., 2009).

Thai has three-way contrasts, which are uncommon: voiced /b/, voiceless unaspirated /p/, and voiceless aspirated /ph/. Studies investigating stop perception in Thai adults showed that VOT is a robust cue. To date, no studies have assessed how these native contrasts develop during early speech perception. The present study focused on the development of Thai infants' discrimination of Thai stop contrasts: /b/-/p/ and /p/-/ph/. To evaluate the extent of universality of the ±30 VOT boundaries, we compared results from parallel studies with 4-to-6-month-old Korean (N = 25 × 2) and Japanese (N = 24 × 2) infants who participated in a visual habituation-dishabituation paradigm (Stager & Werker, 1997) using identical natural stimuli.

Two experiments were carried out. The first employed a /bee/-/pee/ contrast for Thai infants from two age groups (N = 24 × 2): 4 to 6 and 8 to 10 months, while the second employed a /pee/-/phee/ pair with age groups (N = 24 × 3): 4 to 6, 8 to 10, and 11-13 months. We selected ten instances of naturally produced nonsense words with a mid tone: /bee/, /pee/, and /phee/ (average VOT of -120, 8, and 140, respectively). We expected the discriminations to be easily achieved for these young infants regardless of their language background because the members of each stimulus pair crossed the proposed ±30 boundaries.

The results showed that 4- to 6- and 8 to 10-month-old Thai infants could reliably discriminate (native) /bee/-/pee/ pairs ($F(1, 45) = 30.06$, $p < .01$), but not (native) /pee/-/phee/ pairs. The latter contrast was only discriminated by the 11- to 13-month-old infants ($F(1, 96) = 13.32$, $p < .01$), with a significant directionality effect. Interestingly, 4-to-6-month-old Korean infants were also able to discriminate (non-

native) /bee/-/pee/ pairs, but not (non-native) /pee/-/phee/ pairs (Choi et al., 2020). In the case of Japanese, 4-6 month-olds could discriminate (non-native) /pee/-/phee/ pairs, but only when habituated to /phee/ ($t(11) = 3.50$, $p < .01$), but not (non-native) /bee/-/pee/ pairs.

Conjointly, these new findings from young infants learning Asian languages suggest that discrimination of stop categories does not necessarily follow the typical developmental trajectory of perceptual narrowing and thus raises questions about the generality of the language-general ±30 VOT boundaries. It is plausible that initial language exposure is more important in shaping the discrimination patterns than previously thought.

P2-D-307 - A longitudinal study of amodal phonological abstraction in infants

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Details

A recent study with adult Dutch speakers adopted from Korea before 6 months challenges the prevailing belief that infants must undergo perceptual attunement to native speech, which emerges in the second half-year of life, before they can form abstract phonological representations. These adoptees performed significantly better than Dutch controls lacking prior Korean exposure at 1) learning to categorise the 3-way Korean [t*]-[t]-[t^h] contrast, and 2) generalising that ability to other places of articulation, and 3) producing the contrast at all places of articulation without further training (Choi et al., 2017). These findings imply that the adoptees had already formed phonological feature abstractions about their birth language prior to 6 months. However, phonological feature abstraction has not been directly tested in infants. We investigated early amodal phonological abstraction in infants under six months and –retested at two points in the presumed perceptual attunement period. 26 infants acquiring Australian English were longitudinally tested at 4-5 months, 7-8 months (native vowel attunement emergence: e.g., Polka & Werker, 1994), and 10-11 months (Time Point 3, native consonant attunement emergence: e.g., Werker & Tees, 1984). Infants were trained to associate different cartoon animals with audio-only words from two artificial mini-languages that used only labial (lips) or only coronal (tongue tip) consonants (e.g., labial language: *bi-va-wo;* coronal language: *dæ-zu-la*). Different words and animal pairs were used at each age. The subsequent looking-time test presented video-only (silent talking face) novel words of each language paired with Congruent (matching) or Incongruent (mismatching) animals. Infants looked significantly longer to Congruent than Incongruent trials at 4-5 months (Figure 1), indicating that they had abstracted amodal information about the place of articulation distinction prior to native perceptual attunement. However, Congruent vs Incongruent looking times did not differ at 7-8 or 10-11 months (Figure 1). We also measured receptive vocabulary (Communicative Development Inventory, short Australian version [OZI-SF]: Jones et al., 2022) at 12-14 months; vocabulary size was not predicted by looking scores for any age. The lack of looking preferences at the older ages may reflect a shift toward other phonological abstractions (stress patterns, word boundaries, phonotactic regularities), and/or the 8-12 month shift in attention from mouth to eyes in audiovisual speech. Examining other phonological feature contrasts or infants acquiring languages with different consonant inventories could offer insights into the developmental relationship between phonological abstraction and perceptual attunement.

P2-D-308 - How are language exposure and brain myelination related in early development? A preregistered longitudinal study

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Details

During the first few years of life, there is a period of rapid brain growth followed by an increase in brain myelination (Deoni et al., 2012). This is also a period of rapid behavioural change, with major advances in the acquisition of language (Hoff, 2006) but also profound variability among children (Frank et al., 2021). These individual differences have been associated with children's early experiences with language, such as the amount of speech that they are exposed to (Rowe, 2012). Some research has shown links between language exposure and myelination of language-related brain areas in infancy (Fibla et al., 2023), and childhood (Romeo et al., 2018). To date, however, it is unclear how these links emerge over time. Here, we report results from the first longitudinal study to look at the impact of early language on brain development in two groups of children: a 6-month-old cohort studied at 6, 18 and 30 months and a 30-month-old cohort studied at 30, 42 and 54 months.

We used MRI to quantify concentrations of myelin in specific fibre tracts in the brain. Our central question is whether Language Environment Analysis (LENA) measures from in-home recordings predict myelin concentrations over the course of development in language-related fibre tracts. Additionally, we gathered and controlled for environmental variables such as maternal education as previous studies have shown relationships between the characteristics of the home environment and brain development (Brito et al., 2020; Fibla et al, 2023).

Longitudinal LENA mixed effects models show that older children from homes with more highly educated mothers hear larger quantities of adult words (β = 0.11, p < .001; Figure 1) and exchange more conversational turns with their caregivers (β = 19.36, p = 0.030). Additionally, children from homes with more highly educated mothers produce more vocalisations (β = 89.48, p = 0.020). This suggests that specific characteristics of the home environment, such as the level of maternal education, influence language exposure over development as well as children's own productions.

Our planned analyses will look at the longitudinal stability of the LENA data using longitudinal growth models, and the impact that maternal education has on language exposure over time. We will extract individual coefficients from these models (intercept and linear growth) to quantify changes in language exposure data over time. Additionally, we have created longitudinal brain models using a modified multilevel gompertz model (Dean et al., 2014), from which we have estimated 4 parameters for each child (Figure 2): 1) alpha: the point of transition from rapid to reduced growth; 2) beta: the initial lag of growth;

3) gamma: the slope of rapid growth; 4) delta: the slope of later growth. Relationships between LENA and myelin models will characterise how language exposure relates to brain development. A pre-registered analysis plan and hypotheses can be found at https://osf.io/hkj85/ .

This study will reveal relationships among children's early environments, their language experiences and brain myelination within individuals, bringing new insights into how language exposure and brain myelination are related in early development.

P2-D-309 - Mother thinks she knows best—and maybe she does!

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Details

Infants can learn the names of objects during everyday, playful interactions with their mothers (e.g., Callanan & Sabbaugh, 2004; Gelman et al., 1998), suggesting that attention-directing behaviors, such as labeling and object motion, fuel children's lexical category formation (Havy & Waxman, 2016; LaTourette & Waxman, 2022). Yet, infants' category formation is typically assessed using visual fixation paradigms. But how do parents teach about categories? To our knowledge, no research has explored children's category formation during "guided play"—child-led and parent-supported play (Weisberg et al., 2013). In this study, 59 mothers and their 11- to 14-month-old infants (M_{age} = 12.11 months, *SD* = .93, 26 female) were randomly assigned to play with either four toys from an artifactual toy category (vehicles or tools) or four toys from a biological toy category (animals or fruits). Mothers were asked to play with their infants and teach them the superordinate label (e.g., animal) rather than the basic level labels (e.g., zebra, lion). We asked: 1) How do mothers use superordinate labels to teach their child the names of a group of toys? 2) What are the differences in the way mothers teach their infants about artifactual categories compared to biological categories? 3) How do mothers' label choices relate to children's receptive vocabulary?

Despite instructions to teach their infant superordinate labels, mothers displayed a strong preference for teaching basic level toy names instead. Wilcoxon Signed-rank test showed that mothers used significantly more basic category labels (*median* = 11) than superordinate category labels (*median* = 6), *z* = -2.16, *p* = .031. Mann-Whitney U tests revealed there was no difference in use of *superordinate category labels* between mother-infant dyads who played with biological categories (*median* = 6) and those who played with the artifactual categories (*median* = 7), *U* = 398.50, *z* = -.27, *p* = .78. On the other hand, there was a significant difference in use of *basic level labels*, with biological categories (fruits and animals) (*median* = 17) than the artifactual categories (tools and vehicles) (*median* = 6), *U* = 163.50, *z* = -4.20, *p* < .001. Pearson correlation revealed there was no significant association between the proportion of superordinate labels mothers produced and children's receptive vocabulary, as measured by the MCDI (*p* = .139).

Mothers' preference for teaching children basic level labels over superordinate category labels may be rooted in the assumption that until children are familiar with basic level names, superordinate names might be confusing or misattributed as basic level names. Mothers may support their child's category

learning in this way: knowing which words their child already understands aids their decision in which labels to provide. Similarly, parents may offer shorter rather than longer words, e.g., cop vs. policeman, in light of their assessment of what children can say. This study demonstrates caregivers' preferences and practices that guide their infants' early learning experiences, bringing us closer to bridging the gap between research and real-life scenarios. Maybe mothers do know best.

P2-E-310 - Parents of toddlers who are deaf/hard-of-hearing use more desire verbs and fewer feeling verbs than parents of toddlers with normal hearing

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Details

Research has shown that preschool- and school-aged children who are deaf/hard-of-hearing (DHH) have more difficulties understanding other peoples' beliefs, desires, and feelings compared to children with normal hearing (e.g., Netten et al., 2017; Sundqvist et al., 2014). DHH Children also use fewer and less diverse mental state verbs (e.g., *know, want*, and *feel*), which indicate their ability (or possible difficulties) to reflect on their own and other people's beliefs, desires, and feelings (e.g., Vachio et al., 2023). In this study, we investigated one possible early contributing factor to these findings – use of mental state verbs during parent-child pay by parents of DHH toddlers compared to parents of normal-hearing peers.

Three groups of toddlers (N = 37, age range: 6-32 months, 21 girls) and their parents participated in the study. Two groups of DHH children used either cochlear implants (subsequently termed the CI group, N = 13) or hearing aids (HA group, N = 12). Children in the third group (N = 12) had normal hearing (NH group). During their lab visits, parents and children participated in three toy-play sessions in which they engaged in different types of play (i.e., building Lego blocks, dressing a toy kitten, or preparing food for a baby doll) and a session where they ate snacks prepared by experimenters or by themselves. We transcribed parents' speech and coded the types of mental state verbs parents produced during the sessions. The mental state verbs were coded into three categories: cognitive (e.g., *know, think*, or *remember*), desire (e.g., *want, need*, or *care*), and feeling (e.g., *feel, like*, or *enjoy*).

During the play sessions, parents in the three groups produced comparable amounts of utterances and had comparable levels of utterance complexity, as measured by the mean length of utterance in words (see Table 1). Parents in the three groups also produced comparable amounts of mental state verbs. Within each group, parents used more desire verbs than other types of mental state verbs (see Figure 1). However, across groups, there were also significant group differences in the proportions of different types of mental state verbs parents used. Parents in the CI and HA groups used significantly more desire verbs than parents in the NH group ($ps < .01$). In contrast, parents in the NH group used more feeling verbs compared to parents in the CI and HA groups ($ps < .01$). There was no difference in the CI and HA groups in terms of their use of mental state verbs.

Overall, parents of DHH children were more likely to talk about children's wants and needs than parents of NH children. On the other hand, parents of NH children were more likely to take about different feelings than parents of DHH children. Whether and how these differences may be associated with children's use of mental state verbs later in development and their understanding of other's beliefs, desires, and feelings are still open questions. Further research is needed to investigate whether these differences predict children's later language and social development.

P2-E-311 - The role of pitch contour shape in expressing social purpose in infant babbling

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Details

Introduction: Preverbal vocalisations form a central part of infants' earliest communication skills. Evidence suggests that infants can systematically vary the intonation of their vocalisations dependent on its social purpose. For example, English-acquiring (Papaeliou & Trevarthen, 2006) and Catalan-acquiring (Esteve-Gibert & Prieto, 2012) infants aged 7-11 months produced vocalisations directed at a communicative partner ('communicative purpose') with a broader pitch span and shorter duration, compared to vocalisations not aimed at a communicative partner ('non-communicative' purpose). This was demonstrated by analysing pitch as scalar and static values. Since pitch is a dynamic and continuous variable, the current study extends previous analyses by asking whether infants also modulate pitch contour shape to express communicative versus non-communicative purposes in babbling in Catalan.

Hypotheses: We hypothesized that pitch contour shape differs between vocalisations serving communicative versus non-communicative purposes, based on Flax et al. (1991) and D'Odorico & Franco (1991) examining the use of contour shapes in social contexts in 11-22 months English-acquiring and 4-11 months Italian-acquiring infants respectively. We predicted that communicative vocalisations would entail steeper slopes that tend to rise, whereas non-communicative vocalisations will entail flatter slopes that tend to fall.

Method and study population: Esteve-Gibert and Prieto (2012)'s corpus from four Catalan-acquiring infants was used to test our hypothesis. The corpus was collected during weekly 30-minute free-play caregiver-infant interactions at their homes between ages 0;7 and 0;11. Vocalisations were annotated for social purpose using the codes 'communicative', 'non-communicative' and 'not clear'. 750 vocalisations that equally represent three age groups (0;7, 0;9, 11;00), three participants (two male, one female), and two social purposes (communicative, non-communicative) were semi-randomly selected for the current purpose. A functional data analysis (Gubian et al., (2015) was done using the 'Automatic Annotation of Speech Prosody' tool (Hu et al., 2020). Two Functional Principal Components (FPC) were analyzed and separate linear mixed-effects models were constructed for two outcome variables (FPC1, FPC2) using the 'lme4' package in R.

Results: The acoustic analysis revealed that the average pitch contour shape across social purposes and age groups is a hat-shaped curve. FPC1 explains μ =35% of the variance in pitch contour shape with positive weights causing an earlier fall in the pitch contour and negative weights, a more delayed fall. FPC2

explains μ =32% of the variance with positive weights causing a terminal rise, and negative weights a steep, terminal fall. Statistical analysis revealed no main effect of social purpose or age on FPC1 or FPC2. See attachment 1 for an illustration of the average curve (solid line), and the influence of a positive and negative FCP1 and FPC2 weighting thereon.

Conclusion: Our study did not yield evidence for a role of pitch contour shape in the expression of social purpose in babbling in Catalan. We did however observe a plausible developmental trend in the timing of falling contours, being that younger infants tend to produce earlier falls and older infants produce more delayed falls. This trend suggests the development of increased phonatory control as infants mature from 0;7 to 11;00 months.

P2-E-312 - How consistent is mothers' speech to infants From 4 to 12 Months?

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Details

The influential work of Hart and Risley (1995) fueled the view that individual differences in caregiver speech to infants are large, systematic, and predictive of infants' later language (e.g., Hirsh-Pasek et al., 2015; Rowe, 2012). Various studies confirm that caregiver infant-directed speech (IDS) is varied, and that specific IDS parameters can predict significant variance in specific indices of infants' and toddlers' language skills (e.g., Liu et al., 2003; Weislader & Fernald, 2013). However, basic facts about the stability and predictiveness of maternal IDS features are sparsely documented (e.g., Henning et al., 2005). The Hart and Risley study showed month-to-month individual differences in IDS, but in a sample with high socioeconomic diversity, and SES is correlated with numerous variables related to education, language abilities, and literacy (e.g., Hoff & Laursen, 2019).

For a more focused test of the limits of longitudinal stability and consequences of variable parameters of caregivers' IDS, we followed N=42 middle-class, English-using, North American mothers of infants (5% Asian; 7% Latinx; 12% multi-racial; 76% white) longitudinally from 4 - 12 months, focusing on mothers' speech quantity, lexical diversity, and discourse content. We related these to their infants' language skills from 12 - 22 months. Mothers were relatively well-educated (mean = 16 yrs. schooling) and older than average (mean = 32 yrs.), allowing a relatively conservative test of stability of individual differences in IDS.

We transcribed mothers' speech to infants during in-home, unscripted toy-play sessions, held monthly from 4 to 9 months and at 12 months. Some aspects of sessions were standardized (e.g., toys provided; setting and situation within the home) to reduce incidental variance. The 12-month session featured more toys and mobility. Transcription, reliability, and analyses are complete for all months except two (5 and 7), which are mostly complete.

Monthly descriptive statistics (means, *SD*) for quantity and lexical diversity, and discourse content (declaratives, imperatives, questions) are shown in Table 1. All measures showed significant individual stability. Token rate was stable across months: average Pearson r_{mean} = 0.711 (range = 0.58 to 0.84).

Type rate was nearly as stable; Pearson r_{mean} = 0.618 (0.38 to 0.79). Utterance rate (Figure 1a) was as stable as type rate, so speech quantity and richness were moderately stable from 4 to 12 months. Discourse content shows moderate stability (Figure 1b-d), indicating consistency in maternal speech style (Kuchirko et al., 2019).

Preliminary correlations between maternal IDS parameters (standardized by month; averaged over 4-9 months), and infant language indices (Macarthur Communicative Development Inventory: 12 and 22 months; Bayley Scales of Infant Development: 12 and 18 months), partialling out maternal education, show non-significant but positive associations. The strongest were between infants' MCDI vocabulary at 22 months (*N*=25) and: maternal token rate (*r*= .272), type rate (*r*=.24), and utterance rate (*r*= 0.36; *p* = .086). None, however, was reliable. These results suggest that even in a relatively SES-homogeneous sample, maternal input quantity, diversity, and style are moderately stable, but only modest predictors of subsequent language skills.

P2-E-313 - What makes atypical communication development most atypical?

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Details

The development of communication is a dynamic process that begins with early social interactions in the pre-linguistic phase of development. With the acquisition of spoken language, the child communicates for an increasing number of different purposes. Thus, in the second year of life, the child communicates for many different functions. In addition to the variety of functions for which a child communicates, a characteristic of a typical communication pattern is the frequent initiation of communication and high frequency of reciprocal social communication. Deficiency in these characteristics indicate an atypical communication pattern observed in children with autism spectrum disorder. The reduced or absent initiation of social interaction, the use of language only for specific functions such as requesting or naming, and the lack of use of language for clarification, sharing feelings or conversation, reduced initiation of social interactions and reduced reciprocal social communication are some of the characteristics mentioned in the diagnostic tools for this disorder (for example in the Diagnostic and Statistical Manual of Mental Disorders-5 (APA, 2013) and the Autism Diagnostic Observation Schedule-2 (Lord et al., 2012)). However, autism is described as a spectrum that presupposes certain variability in communication skills. Therefore, it is not clear whether certain deviations in communication are equally expressed in all children. The lack of description of the communication pattern of typically developing children also contributes to the lack of a clear picture of the disorder.
The aim of this study was to compare the communicative characteristics of 10 typically developing children aged 2 years and 10 children with autism spectrum disorder at the same language level. All participants showed non-verbal skills in the average range. Variables compared included the proportion of initiation of verbal communication, the total number of communication functions and the average number of communication acts per minute.
The participants were observed interacting with their mothers using The Communication Play Protocol (Adamson & Bakeman, 2016). All verbal communication was transcribed and coded according to adapted Wetherby's (1986) classification of communicative functions.

The results show a statistically significant difference in only one variable, the total number of communicative functions, in favor of the typically developing children who communicated in a higher number of functions. The other two variables, the proportion of initiation of verbal communication and the average number of communication acts, show no statistically significant differences between typically developing children and children with autism. The results will be elaborated in more detail on the qualitative level.
The results indicate that not all atypical communication characteristics are equally pronounced in all children with autism. It appears that the range of communicative functions is one of the most atypical characteristics of communicative development of children with autism. On the other hand, the frequency of communication as well as the initiation of communication were similar in children with autism and language matched 2-year-old children with typical development in our sample.

P2-E-314 - Educators' commands and toddlers' responses in free play: a comparative study between China and Japan

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Details

As the most commonly used type of instructional language, commanding language is used by early childhood educators to guide the behaviour of children or to organize daily routines. The use of commanding language has a profound impact on the cognitive and social development of children, and is an important indicator of the quality of educator-child interactions. According to Systemic Functional Linguistics commanding language is classified into *direct & non-suggestive*, *direct & suggestive*, *indirect & non-suggestive*, and *indirect & suggestive*. In communication, different types of commands differ not only in lexical grammatical expressions, but also in the tone of voice and actual instructional effect.

This study investigated Chinese and Japanese educators' use of commanding language to toddlers aged 24-36 months and the toddlers' responses to commands in free play. Positive responses are manifested as toddlers following and acting according to the educators' commands, while negative responses are manifested as toddlers ignoring or refusing to act as commanding). This study collected videos of educator-toddler interactions during free play between Chinese and Japanese native educators, and coded and analyzed a total of 2,478 utterances produced by these educators during 30 minutes of free play interactions using corpus analysis (coding scheme in Table 1). In conjunction with video observation, the toddlers' responses to each of the educator' command were recorded.

The results indicate that Chinese educators uttered significantly more commands than Japanese educators, with Chinese educators using commands 2.6 times more frequently than Japanese cohorts. Regarding the four types of commands, Chinese and Japanese educators showed agreement: *direct & non-suggestion* commands were dominant and rated significantly higher than the other three types. In particular, Chinese educators used *direct & non-suggestive* commands significantly more than Japanese educators, while Japanese educators used the other three types of commands significantly more often than Chinese cohorts. There was no significant difference between Chinese and Japanese toddlers'

responses to commands, with positive responses dominating, and toddlers' responses to commands were not affected by different types of commands. (Figure 1)

From the results, we can find that *direct & non-suggestion* command is the dominant commanding language used by Chinese and Japanese educators when interacting with toddlers. There is not much difference in the response between Chinese and Japanese toddlers, and both of them are dominated by positive responses. This suggests that toddlers are able to understand adult commands and respond positively in line with expectations, and Chinese and Japanese educators' instructional behaviors are effective. It also indicates that toddlers are less sensitive to different types of commands during free play.

In conclusion, this study focused on educators' commanding language to toddlers and toddlers' responses in different cultural-linguistic context, which has implications for the improvement of the commanding language use of early childhood educators worldwide, and for the development of high-quality educator-child interactions in terms of the construction of language environments.

P2-E-315 - Comprehension and production of subject-verbal number and tense agreement by French-learning 40-month-olds

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Details

Verbal agreement is of high importance in morphosyntactic development and a relevant marker in language development disorder (Van der Lely, 2005). However, few studies on subject-verb agreement acquisition in young children with typical development are available in French, especially comparing number and tense along with comprehension and production. For comprehension, only number agreement was tested, with comprehension of liaison-based number agreement marking found at 30 months (Legendre et al., 2010). Interestingly, Ågren et van de Weijer (2013) described an asymmetrical pattern (plural verb forms more easily comprehended than produced and conversely for singular), in 5-10-year-old children. These patterns are also found in other languages, in particular inn English with present 3rd person singular (verb+/s/) versus 3rd person plural (verb+no mark) in 5-6-year-olds, but not in 3-4-year-olds (e.g. Johnson *et al.*, 2005). For production, most milestones come from spontaneous production analysis and parental reports. Thus, Bassano *et al.*(2020) report that 90% of toddlers produced the present tense in the 3rd person singular at 27 months and the perfect (*passé composé*) and near future (*futur proche*) at 34 months, while the present 3rd person plural is produced by more than 50% of toddlers at 30 months.

Here we compared 40-month-old monolingual Swiss French-learner's (n=30) ability to understand and produce number and tense subject-verbal agreement (with double markers: determiner + verb; see examples in Table 1). Six early-acquired verbs requiring overt number and tense marking (*finir* 'to finish', *nourrir* 'to feed', *conduire* 'to drive', *construire* 'to build', *mordre* 'to bite', *perdre* 'to loose') were presented with a noun phrase in four conditions (24 utterances), to allow both number (3rd person present singular versus plural) and tense (perfect versus near future) comparisons. Toddlers first did a picture

elicitation task based on still drawings (see Table 1) with lexical and morphosyntactic scaffolding, and then matched sentences to dynamic gifs of the same drawings in a pointing task.

Figure 2 shows performance in the 4 conditions in comprehension and production. Data were not normally distributed, requiring non-parametric Wilcoxon tests. For number (present), both singular (p=.002) and plural (p<.001) were understood above chance, but no significant difference was found between them in comprehension (p=.222). However, singular was produced significantly more than plural (52% versus 22%, p<.001). For tense, past (p<.001) was understood significantly above chance but not future (p=.109), with a significant difference between them (p=.006). Both were still poorly produced with no significant difference (33% and 31%, p=.830).

Our results show that French-learning 40-month-olds still show more difficulties in future comprehension and future and perfect production, as well as an asymmetry between 3rd persons singular and plural comprehension and production. We will discuss the reasons in connection with crosslinguistic literature, analyze and discuss links between our experimental results and children's performance on standardized language tests, as well as children's errors and effects of prompting.

P2-E-316 - Effects of a digital early years language service on parent-child interaction, infant communication and child vocabulary: Evidence from an RCT

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Details

This RCT tested the infancy phase of a digital language intervention designed to mitigate the effects of relative socio-economic disadvantage on language skills before school entry. Language delays associated with disadvantage put children at risk of entering a cycle of educational inequality from early in life. One approach to preventing language delay is to deliver digital parenting services that provide caregivers with specific developmental-stage-related strategies to scaffold language development in a manner that is acceptable to parents/caregivers. We tested whether starting such a text-based service when infants are approximately 6 months of age can promote caregiver-infant interaction and whether this benefits infant communication and word learning.

Families from across the four nations of the UK (N = 435) were randomised to receive either a language text service or an (active control) physical health text service. Infants were born full term and had no known health conditions affecting language development upon enrollment and heard English at home at least 80% of the time. These constraints given, infant ethnicity was representative of the UK population. Family postcodes were equally spread across each of the first 5 deciles in national Indices of Multiple Deprivation. For the 18-month duration of the study, families received 3 text messages a month with a link to video content relevant to their service (language / physical health). For the language condition, high-quality videos were supplied by BBC Education's Tiny Happy People service. For the physical health

condition, they were provided by the National Health Service and related providers. Acceptability of both text services was high (91% would recommend it to a friend).

Outcome measures derived from questionnaires and home videos were collected via smartphone. Home videos (N = 125 or greater) were coded for caregiver linguistic responsiveness (measured using the PARRIS at 12, 17 and 24 months), infant prelinguistic communication (12 months) and child vocabulary (17 and 24 months). Questionnaires included parent reports of infant expressive vocabulary (N = 400 at 17 months, and N = 399 at 24 months).

Pre-registered analyses (clinicaltrials.gov) found a significant effect of condition on parental linguistic responsiveness as measured by the PaRRiS such that caregivers in the language group were 2.5 times more likely to have a higher PaRRiS score than those in the active control group. Infant prelinguistic communication (blind coded from home videos), also showed an effect of condition such that 12-month-old infants in the language condition produced 1 extra prelinguistic communicative act per 5 minutes of recorded interaction. Child vocabulary (blind coded from home videos) showed a marginally significant effect of condition. However, for caregiver-reported child vocabulary there were no significant differences across conditions.

Along with post-intervention caregiver focus groups and other recent studies (List et al., 2021), these findings suggest that to promote child language ahead of school entry, we need to provide higher-intensity support while retaining a low-pressure style that parents appreciate. This can be achieved by following principles of proportionate universalism (Molloy et al., 2020) and we describe a pilot RCT currently underway to test this.

P2-E-317 - More iconic caregiver speech is associated with more infant engagement in interactions

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Details

Iconicity plays an important role in early communication. Words are iconic if there is some resemblance between their form and meaning as with onomatopoeias, such as *squeak* and *boom* and words in other semantic domains such as *wiggle* and *teeny*. Children learn iconic words earlier than other words, and they are used disproportionately often by infants and caregivers. Previous research has suggested that iconic words scaffold word-learning because they help infants establish referentiality or because they have phonological structures that are easy to articulate. Here, we test a hypothesis derived from the idea that one function of iconicity is to increase infants' engagement in communication. We hypothesized that high iconicity in caregiver speech would be associated with high infant engagement. In Study 1, we examined video-recorded naturalistic interactions between five 18-month-old English-speaking infants and their caregivers using iconicity ratings of words to measure iconicity in the mothers' speech. For each dyad, we identified 10 high and 10 low iconicity bouts by calculating the rolling average iconicity per 5 words. Infant behaviour within a 5-second window before and after words with the highest and lowest rolling averages within the interaction was coded for features related to engagement. Results showed that highly iconic caregiver speech was more engaging to infants. In high compared to low iconicity bouts,

infants gazed more at their caregivers, gazed more at the subject of conversation, and more often smiled, laughed, gestured and verbalized. In Study 2, a registered report currently under review with Developmental Psychology, we will apply the same coding and analyses to a new sample of 54 video-recorded English-speaking infants and caregivers (age-range:13-23-months, 27 male, 33 white, 15 mixed-race, 6 other). We expect these findings to replicate the findings from Study 1 with infants showing more engagement behaviours in high compared to low iconicity bouts. We are also interested in investigating whether the effect of iconicity is the same across three different age-groups (13-month-olds, 18-month-olds and 23-month-olds). Iconicity in parent-child interactions is multi-functional and our findings have and, we predict, will continue to evidence the inherent fun and engaging nature of these words.

P2-E-318 - Gesture production in Gahvora-reared infants in Tajikistan

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Details

Before children can speak, they often gesture to make their needs known. Gestures—pointing and showing—appear in children's repertoire during the first year of life and persist even after they produce words, often in combination. Gestures allow children to express thoughts or desires that they are not yet able to express verbally, suggesting that gestures may serve a functional role. Studies have found that gestures precede and predict changes in language demonstrating the pivotal role of gestures in language development (Iverson, 2005). Although gestures are communicative in nature, they are fundamentally motor actions: Infants have to coordinate manual behaviors to signal a request or command to a communicative partner. Indeed, studies that have examined gestures in samples of typically developing infants and those at risk for ASD, infants at risk demonstrated a delay in gesture production and a restricted gesture repertoire, perhaps due to motor impairments (Iverson, 2017). Moreover, infants who are immersed in a gesture-rich culture (i.e., Italian) produce gestures in communication more frequently than their U.S. counterparts. We examined the production of gestures longitudinally from 12 to 20 months in Tajik infants. In Tajikistan, infants spend extended periods throughout the day in a gahvora cradle where their limbs are tightly swaddled and bound preventing movement. Does gahvora rearing alter infants' gesture production in infancy? Moreover, do gestures relate to speech production as reported in other studies?

We observed 121 infants at 12, 16, and 20 months of age in Tajikistan. A Tajik researcher visited families in their homes and interviewed mothers about infants' gestures and word use. Mothers reported infants' gesture production from the 12-item gesture subscale on the MCDI communicative inventory, which include deictic (pointing), conventional (shaking head to indicate "no"), and representational (shrugging) gestures. Mothers were asked about the frequency of production, with answer options "not yet," "sometimes," or "often." Consistent with scoring guidelines (Fenson et al., 2007), a gesture is scored as "1" if a parent answered that their child produced the gesture sometimes or often. A gesture is scored as "0" if parents answered that the child had not yet produced it. Mothers were also asked to recall any words their infants were able to produce on their own, for one object or event, spontaneously without imitation. We summed infants' gestures and words produced at each session to obtain a gesture and language score. Given all infants were gahvora-reared, we predict that gestures will be low across this developmental period but the number of words will increase over

sessions as vocalizations may be infants' primary method of communication. Alternatively, since gahvora use decreases over the second year freeing the hands for gesturing, infants may demonsrate increases in gestures and words contemporaneously. Preliminary analyses show that word production increased over session, as expected. Coding and analyses for all variables are ongoing. Our findings may show if there is cultural variation in gesture repertoires found in young language learners reflecting the fundamental role of childrearing practices in shaping gesture production.

P2-E-319 - Investigating the cross-linguistic and specific effects of gesture on early word learning

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Details

Gesture plays a key role in infants' communication before they are able to produce speech. Infants produce their first gestures between the ages of 9 and 12 months, allowing them to communicate before they can talk, however, this is not all that gesture does. Infants' gesture use and comprehension are also predictive of their future language abilities (e.g., Iverson & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009), demonstrating the importance of gesture as a language learning tool. However, much of the existing evidence has been from observational studies in English-speaking settings. The high-intensity nature of these studies means they rely on small sample sizes and often focus on monolingual English-speaking children, limiting their generalisability. Even early in development there are cultural differences in gestural communication (Dale & Goodman, 2005), thus it is crucial to investigate these effects cross-linguistically. Study 1 addressed this issue by using cross-linguistic data collected using the MacArthur-Bates Words and Gestures Communicative Development Inventory (CDI; Fenson et al., 2007) and its adaptations. The use of CDI data also allowed us to investigate the effects of gesture on different word types, which has previously been under-explored. Publicly available data from 8394 participants across 10 languages were used (Frank et al., 2016), giving us an extremely diverse sample of participants. Statistical models of this data indicated that gesture use predicts word learning, and the effects of gesture on word learning differ cross-linguistically (see Figure 1). Furthermore, the effects also differed by word type, with gesture having the largest effect on verb comprehension compared to that of nouns and adjectives. As the gestures in the CDI are largely action-based, this suggests that different gestures confer specific advantages in word learning.

Study 2 investigated this finding further. Because of the implications of gesture for language development, a specific form of symbolic gesture known as baby sign has been developed. The aim of this is to teach infants signs for key words so they can communicate their needs before they can talk, and it is claimed that this has many benefits, such as an enhanced vocabulary and increased intelligence. However, there has been limited research into the effects of baby sign on language development, and many of the claims are based solely on anecdotal data. Therefore, Study 2 addressed this using the Oxford CDI (Hamilton et al., 2000), and a baby sign questionnaire created for the study. So far, statistical models of data from 80 British English infants aged 12-16 months indicate that baby sign does not have an advantageous effect on overall word learning, however, learning signs for objects does have a significantly greater effect on noun learning than verbs. These results are convergent with the finding

from Study 1 that gestures confer specific advantages, as teaching signs for objects aids noun learning, whereas action-based gestures increase action word knowledge. Thus, overall, these findings demonstrate that, while gesture plays an important role in vocabulary development, its effects may be specific and limited.

P2-E-320 - Spurters vs. non-spurters: Comparing vocabulary size and language exposure in infants who do and do not show a vocabulary spurt

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Details

Sometime before their second birthday, many children show a period of rapid expressive vocabulary growth called the vocabulary spurt (Ganger & Brent, 2004; Silvén et al., 2014). Researchers have posited that all typically-developing children show a vocabulary spurt, albeit some might show it later than what would classically be expected (D'Odorico et al., 2001; Rescorla et al., 2000). Others have argued that not all children follow this vocabulary acquisition trajectory, with proportions of spurters ranging from 20% (Ganger & Brent, 2004) to 72% (Goldfield & Reznick, 1990 in Ganger & Brent, 2004). The cases where infants appear to not show a vocabulary spurt may be due to them undergoing a spurt outside a study's age range, and therefore not being captured, or children acquiring vocabulary more slowly, therefore showing a less evident or absent vocabulary spurt, as it has been observed in late talkers (Rescorla et al., 2000). We consider an additional possibility: some infants who appear to not show a vocabulary spurt may have less language exposure, and therefore acquire vocabulary more slowly and gradually. We aimed to understand differences between spurters and non-spurters by examining their vocabulary size and language exposure.

Dense, longitudinal data was analyzed from 45 English-French bilingual and monolingual infants aged 16-30 months. Language exposure was measured via a structured interview with parents (Bosch & Sebastián-Gallés, 2001), from which we estimated relative exposure to each language and exposure balance. English and French expressive vocabularies were measured monthly using the MacArthur-Bates Communicative Development Inventories (Boudreault et al., 2007; Marchman et al., 2023). We computed three vocabulary scores: single-language (English and/or French), concept (number of concepts lexicalized across both languages), and word (sum of both languages) vocabulary.

We determined whether infants showed a vocabulary spurt in each vocabulary type by fitting a logistic curve to each infant's data and estimating its midpoint. Infants with a midpoint within the study's age range were considered spurters. 76% of infants showed a spurt in at least one vocabulary type (i.e., English, French, concept, and word), and bilinguals were more likely to show a spurt in their dominant than their non-dominant language. Spurters had larger vocabulary sizes at 18 and 30 months in all vocabulary types compared to non-spurters. For single-language vocabularies, spurters had higher language exposure than non-spurters. For concept and word vocabularies, spurters had less balanced exposure than non-spurters (see Table 1).

We found that non-spurters had smaller vocabulary sizes, which could be attributed to factors internal or external to the children. Some infants may have a slower learning rate (e.g., late talkers) and therefore not show a vocabulary spurt. The language environment may also play a role, as we observed that non-spurters had lower and less balanced language exposure. A smaller or absent vocabulary spurt may not necessarily indicate a delay in vocabulary acquisition, especially if an infant shows a spurt in one of their languages. Our findings will help families raising bilingual children, educators, and health care professionals accurately assess early language milestones and better identify potential language delays.

P2-F-321 - Using EEG coherence to examine neural functional connectivity during social tasks across the first year

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Details

We examined early default mode network (DMN) and general attention network (FPN) using EEG coherence across the first year during two tasks with different social demands. From previous research we know that both networks show development during the first year (Gilmer et al., 2018) and infant EEG varies across social and nonsocial contexts (John et al., 2016). We sought to extend the literature by examining EEG during high and and low social demands. Our hypothesis was that both DMN and FPN would vary with different levels of social input and that this effect would be seen across age.

Forty-seven typically developing infants (24 girls) participated in a study by visiting the research lab monthly from 5 to 12 months. At each visit, EEG was recorded during two social tasks. During the low social demands task, the experimenter manipulated a toy with bouncing balls for one minute and did not talk to the infant while the infant sat on parent's lap and observed. The infant could choose whether to attend to the experimenter. EEG was recorded continuously. During the high social demands task, the experimenter made eye contact with the infant and presented a small toy animal and said "Look! Do you want it? Here it comes!" and slowly moved the toy toward the infant for the infant to grasp. This was repeated with 15 total animal toys and with each trial the experimenter persisted at gaining the infant's attention before moving the toy forward. EEG recordings were event marked so that analyses only included EEG from the word "look" until the toy was within grasp of the infant. EEG across the 15 toy trials was averaged. Left hemisphere EEG coherence at 6-9 Hz (infant alpha) was calculated for Fp1P7, aligned with the default mode network (DMN) in adults (Rojas et al., 2018), and for F3P3, aligned with a more general attention network (Posner et al., 2016).

Repeated measures MANOVA showed all main effects and 2-way interactions were significant and superseded by a 3-way interaction between social demands (low, high), network (DMN, FPN), and age (5-12 months): Hotelling's=.060, F=2.015, p=.05. As shown in Figure 1, both social tasks exhibited greater FPN coherence than DMN coherence, which was as expected since the FPN is typically an indicator of general attention to a task. Additionally, the FPN for the high social demands task has higher EEG coherence than the FPN for the low social demands task suggesting that infants were more attentionally engaged with the high social demands task.

Simple effects testing showed that the DMN and FPN coherence values for the low social demands task at each age were significantly different from each other (all p's<.029). The same was true for the DMN and FPN coherence values for the high social demands task at each age (all p's<.001). Finally, the DMN and FPN values for each task showed developmental changes from 5 to 12 months, with each showing increased EEG coherence with age (all p's<.001). The unexpected exception was DMN during the low social demands task, which showed lower EEG coherence values at 12 months compared to 5 months.

Our data suggest functional networks can be assessed developmentally during the first year with EEG coherence.

P2-F-322 - The impact of audiovisual exposure to own- and other-race faces on face recognition in 9- to 12-month-old white infants

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Details

Background: Across the first year of life, infants develop specialized face processing skills based on experience. This specialization can be seen in the development of the other-race effect (ORE), characterized by better processing and recognition of faces that belong to one's own race, compared to faces of other races (Kelly et al., 2007). The ORE is sensitive to environmental factors and can be diminished by early experiences with other races (e.g., Heron-Delaney et al., 2011). However, types of experiences that lead to a diminished ORE are still not well understood. For example, synchronous audiovisual stimuli elicit increased attention in infants relative to asynchronous or visual only stimuli (Reynolds et al., 2013, 2014) and some studies indicate that audiovisual exposure to other-race faces may diminish the ORE, allowing infants to discriminate between faces of other races (e.g., Minar & Lewkowicz, 2018).

Objective: This study investigated the influence of audiovisual exposure on own- and other-race face processing in 9- to 12-month-old infants. Infants viewed synchronous and asynchronous audiovisual presentations of own- or other-race faces across familiarization trials and face recognition was tested using visual paired comparison (VPC) trials.

Method: Eighty 9- to 12-month-old White infants participated online via Children Helping Science (see Table 1 for demographics). Participants were familiarized with side-by-side videos of two own-race (*N* = 27) or two other-race (*N* = 53) actors reciting a children's story, where the soundtrack matched only one of the videos. Following familiarization, three VPC trials were presented in random order: 1) the familiarized-synchronous face and familiarized-asynchronous face; 2) the familiarized-synchronous face and a novel face; and 3) the familiarized-asynchronous face and a novel face. Looking preferences were tested using paired-samples t-tests. Faces presented synchronously during familiarization were expected to recruit greater attention than faces presented asynchronously. However, synchrony was expected to draw attention away from facial characteristics relevant to face processing, preventing recognition of the familiar-synchronous face. Infants may recognize the asynchronous face, as audiovisual synchrony

would not distract from face characteristics. Participants in the own-race condition were expected to show greater recognition of the familiar-asynchronous face than those in the other-race condition.

Results: Infants familiarized with other-race faces demonstrated a preference for the asynchronous face (M = 16.20, SD = 4.54) compared to the synchronous face (M = 13.51, SD = 2.78) during familiarization, $t(52) = -2.39$, $p < .05$, while infants familiarized with own-race faces did not exhibit a preference, $t(26) = -0.76$, $p = .455$ (see Figure 1). During the VPC trials, infants in neither condition showed evidence of recognition of familiar faces.

Conclusion: Although infants attended to own- and other-race faces differently during familiarization, presentation of two audiovisual dynamic faces might have been too complex for full processing and recognition, as neither group recognized familiar faces during the VPC trials. Results show that audiovisual synchrony does not attract attention when viewing competing dynamic faces, and especially other-race faces. This research poses questions to be addressed in future research while highlighting the need for additional research with audiovisual stimuli.

P2-F-323 - Influence of auditory stimulation on rapid visual categorization in 4-month-olds: An FPVS study

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Details

At 4 months of age, children are able to categorize human faces at a glance. However, environmental influences supporting how infants build and recognize distinct categories remain disputed. Early life's multisensory input has been proposed to aid contextual category formation and perceptual development on theoretical grounds, and has received some empirical support (Bremner et al., 2012; Leleu et al., 2020). The current study focuses on the auditory-visual interaction, employing infant-directed speech (IDS), adult-directed speech (ADS) or silence during visual stimulation.

Evidence suggests that maternal odor supports visual categorization performance in children as young as 4 months (Leleu et al., 2020). Whether stimulating senses other than olfaction also boost visual categorization remains an open question. Beyond the finding that children prefer IDS (ManyBabies Consortium, 2020), neurobehavioral research suggests specific neural mechanisms, such as facilitated cortical tracking of auditory input, that underlie the advantages associated with IDS (Kalashnikova et al., 2018). Additionally, IDS can serve as an ostensive cue eliciting referential expectations (Parise & Csibra, 2013; Sirri et al., 2020). It aligns with infant's expectation for a social actor upon hearing human voices, potentially aiding face categorization. The social target category of faces holds a unique status in human perception ever since birth, which is emphasized by studies reporting face-selective neural activity in infants (de Heering & Rossion, 2015).

To examine the impact of concurrently presented IDS versus ADS or silence on visual categorization, fast periodic visual stimulation (FPVS) is employed. Stimuli are presented at a consistent rate of F = 6 Hz (6 images per second), with an image representing the target category shown every 6th position. Social and

non-social target categories are compared using images of faces and cars in a between-subjects design. Target stimuli will be embedded in a randomized stream of highly variable objects. EEG activity is analyzed at both the frequency of stimulus presentation (6 Hz and harmonics) and the frequency of categorization (1 Hz and harmonics) using Bayes factor repeated-measure ANOVAs.

Data collection for the initial sample (N = 55) comparing the impact of IDS and ADS is complete. The sample comparing IDS and silence is almost complete (N = 30, 34 participants to be collected until December 2023). Preliminary results suggest an advantage of auditory signals on visual categorization in 4-month-olds, especially when IDS is paired with the presentation of social targets. If final analyses confirm this pattern, this will emphasize the broader influence of IDS on early sensory and cognitive development.

This study aims to deepen our knowledge about neural correlates of multisensory processing using an innovative EEG method. Moreover, it will contribute to our understanding of the influences of the universally present IDS on general neural processing in infants.

P2-F-324 - Cortical sources of categorization of other-species faces for 6- and 12-month-old infants

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Details

Perceptual narrowing is characterized by a shift from broad sensitivity in early development to a narrower range of stimuli commonly encountered in the native environment (Maurer & Werker, 2014). 6-month-olds can discriminate between novel and “familiar” monkey faces but no longer demonstrate this ability at 9 months (Pascalis, deHaan,&Nelson, 2002), possibly due to categorizing non-native stimuli rather than processing at the individual level (Nelson, 2001). Exposure to multiple exemplars during initial learning has been shown to facilitate subordinate categorization of other-species faces (Dixon et al. ,2019). Studies utilizing event-related potentials (ERPs) have identified the Nc component as a neural correlate of attentional engagement (Richards, 2003). Mature category learning is proposed to be selection-based, characterized by a narrow focus of attention to relevant features (Deng & Sloutsky, 2015). However, infant category learning may be compression-based, driven by a bottom-up process detecting redundancies in visual input. Selection-based category learning may be associated with areas of prefrontal cortex, and compression-based category learning may be associated with inferotemporal cortex and basal ganglia (Ashby et al. ,1998; Best et al.,2013). Cortical source analysis of infant ERP data has identified inferotemporal areas as showing significant effects of attention during Nc response to face stimuli (Conte et al., 2020). We utilized cortical source analysis to identify the neural generator(s) of the Nc component for 6 - (n=24) and 12-month-old infants (n=22) during multiple (n=19) or single (n=26) exemplar learning conditions of monkey faces. The single exemplar learning condition consisted of 20 1000ms presentations of a single monkey face while the multiple exemplar condition consisted of 10 different monkey faces presented twice. High-density EEG was measured while infants were shown novel faces from other monkey species, novel faces from the same monkey species, and familiar monkey faces. Realistic head models were generated for each participant based on head measurements.

Structural MRIs from the Neurodevelopmental MRI Database were used from infants close in head size to each participant (Richards et al.,2015). A finite element method head model was generated with source dipoles restricted to gray matter in Regions of Interest (ROI). Current density amplitude in source locations was estimated with the CDR technique and exact-LORETA (Pascual-Marqui et al.,2011). The ERP data were used to estimate the CDR amplitudes for each ROI. Results were analyzed using a mixed effects model with fixed effects of age, condition (Novel-Other, Novel-Same, Familiar), learning exemplar (Multiple, Single) and ROI (Anterior Fusiform Gyrus (AFG), Posterior Fusiform Gyrus, Middle Temporal Gyrus, and Posterior Inferior Temporal Gyrus).There was a main effect of ROI (F(3,675.93) 4.08, p=.007) and a three-way interaction of age, exemplar, and ROI that approached significance (F(3,675.93) 2.54, p =.06). CDR amplitude was greatest in the AFG across age and exemplar. 12-month-olds showed greater CDR amplitude in AFG in the multiple exemplar group over single exemplar. 6-month-olds showed no significant difference between exemplar group. This may indicate that 12-month-old infant attention to other species faces may recruit brain areas outside the inferotemporal cortex potentially due to a development of selection-based category learning.

P2-F-325 - Impact of musical and motor interventions on infants language

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Details

Children's early language skills are the first predictor of their academic success (Pace, Luo, Hirsh-Pasek, & Golinkoff, 2017). However, from the first year, infants from low socioeconomic status (SES) have systematically lower language abilities (i.e., vocabulary size) than their more advantaged peers (USA: Fernald, Marchman, & Weisleder, 2013, large cohort study ELFE in France: Grobon, Panico, & Solaz, 2019). These gaps widen over time, and have negative impacts on the development of their communication capacities and other skills foundational to science, technology, engineering, and mathematics (STEM). To reduce these gaps, interventions as early as possible are necessary. The goal of the present research is to use musical interventions to stimulate language development in infants from low SES before age 3.

Musical interventions have been successfully used in older children to promote language development (see Bigand & Tillmann, 2020 for a review). Indeed, music and speech signals share many similarities. Practicing music has been shown to stimulate overlapping memory and attentional resources with speech processing, but also induce positive emotional states that improve motivation and thus language learning (see OPERA hypothesis, Patel, 2012 for more details). However, little is known about the impact of such interventions on younger children before age 3. Only two studies showed a positive but limited impact of such interventions in infants from mid to high SES (Gerry, Unrau, & Trainor, 2012; Trainor, Marie, Gerry, Whiskin, & Unrau, 2012). Here, we present a longitudinal study to test whether musical intervention can stimulate language development in infants with low SES.

Infants (age range: 10-36 months) from two French daycares located in priority education networks were selected to participate in this study. In each site, half of the infants participated in musical interventions

(Music condition, N = 27) while the other half (equivalent in age and SES) took part in physical skills activities (Motricity condition, N= 23). Both interventions lasted over 6 months, once a month, 30 minutes per session. Standardized language measurements (Kern, Langue, Zesiger, & Bovet, 2010) were taken before and after the interventions for all infants. For all infants, we predicted that language scores will improve with age. If musical intervention promotes language development, this increase should be greater in the Music condition than in the Motricity condition. According to our hypotheses, after 6 months of intervention, our results show an improvement in vocabulary size for both groups. Interestingly, this improvement was significantly greater for the Music condition ($t(48) = 2.96$, $p < .05$).

As a conclusion, the present study is the first to show that musical intervention can boost language development in infants from low SES under the age of 3. It could have a direct impact on educational policies to reduce inequalities from the earliest years of development. This study highlights the impact that indirect musical interventions on early language development. For more efficiency, it could be taught to education professionals and caregivers, so it would be systematically combined with more direct and classical early language interventions.

P2-F-326 - The development of cortical adaptation from infancy to adulthood

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Details

Cortical adaptation plays a key role in learning, memory encoding, consolidation, and retrieval. Previous works have shown that atypical timescales of adaptation characterize distinct cognitive variations, such as dyslexia and autism. However, little is known about how it evolves across different stages of life. In this study we measured the dynamics of cortical adaptation under equal conditions in infants, children, and adults. Cortical adaptation has been widely researched and replicated in various neuroimaging studies (Kobayashi et al., 2014; Weigelt et al., 2008) and can be used as a marker for memory (Lu et al., 1992). Additionally, cortical adaptation was found related to cognitive disorders in adults and infants such as dyslexia and ASD (Jaffe-Dax et al., 2016; 2017; Granot et al., 2019; Millin et al., 2018; Miron et al., 2016). The adult and infant brain has also been shown to respond differently to repeating visual and auditory stimuli (Emberson et al., 2017), so there appears to be a difference in cortical adaptation between them. Time perception in infants has also shown to be different than children's and adults' (Brannon et al., 2008) While previous research has explored cortical adaptation in specific age groups, less is known about how it evolves across various ages. The nature of the relationship between cortical and cognitive development is poorly understood. In this study, we aim to investigate the development of cortical adaptation from infancy to adulthood. This project will utilize cortical adaptation as a proxy for implicit memory capacity and will track the development of implicit memory aptitude by measuring the timescale of cortical adaptation at multiple points over the course of development. Using fNIRS and an identical task across the age groups we investigate how the temporal, occipital and frontal cortices in the infant, child and adult brain respond to repetition of audio-visual stimuli in varying inter-stimulus-intervals (figure 1). In our preliminary results (N=10 for all groups), we have found that infants recover faster compared to children and adults in the frontal and temporal lobes, indicating that there may be shorter adaptation timescales (faster recovery) in infancy and early childhood and longer timescales

later towards adolescence and adulthood, as we initially theorized (figure 2). We will compare the BOLD response between the different age groups. We hypothesize that adults' BOLD response will have a faster rise, more sustained high level and faster decline compared to children and infants.

P2-F-327 - The operationalization of coordinated attention and the relations to language development: A meta-analysis

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Details

The Operationalization of Coordinated Attention and the Relations to Language Development: A Meta-analysis

331/500 words

Interpreting the intricate link between joint attention (JA) and language acquisition in infancy is crucial for developmental psychology, as it informs early intervention strategies that can profoundly affect cognitive and linguistic outcomes. Our study focuses on how different operational definitions of JA and the timing of developmental measurements influence language development outcomes. Recognizing the variability in JA conceptualization across existing research, this meta-analysis aims to bridge different findings and propose a unified interpretation.

The study examines 46 peer-reviewed articles, involving a comprehensive total of 464 effect sizes, measured via Pearson's product-moment correlation, and encompassing 1482 participants. A systematic literature review was conducted in the databases Google Scholar and PubMed. Adhering to the PRISMA guidelines ensured the selection of relevant and high-quality studies. The meta-analysis contrasts major operationalizations of JA, by initiating and responding to joint attention, and coding schemes focused on specific gaze behaviors, which allows for interpretation of the differences observed between initiating joint attention (IJA), responding to joint attention (RJA), and gaze pattern (GP) which are operationalizations of JA. Our analysis demonstrates that both IJA and RJA are instrumental in language development, although with slight variations in their effect sizes. Furthermore, the study underscores the predictive value of JA in language development within longitudinal designs, particularly for younger children (<8 months), highlighting a crucial window for developmental intervention.

These findings advocate for a standardized approach in future JA research, emphasizing the need for consistency in operational definitions and providing evidence that IJA and RJA may be a better choice for JA operationalization in studies related to language development. Our findings provide further evidence for the importance of longitudinal designs that start at younger ages (<8 months) in JA and language development research. By revealing the role of JA in the progression of early language development, this

study not only advances our understanding of how early social cognitive processes underpin language acquisition but also provides practical implications for educational strategies and interventions aimed at nurturing language skills in early childhood.

P2-F-328 - Searching for Hunter & Ames: Infant looking during a serial novelty task

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Details

Hunter & Ames (1988) proposed that infants prefer a repeatedly presented familiar stimulus before shifting interest to novel stimuli. Mixed results have been found when looking is assessed, however, with some researchers failing to find the predicted pattern (ManyBabies 5 Pre-data collection Registered report, 2023). The goal of the current study was to document preference patterns obtained using a serial task. Data are from 64 infants tested at 3, 5, 7, or 9 months of age. Infants completed two 40-trial serial tasks (i.e., one familiar stimulus presented alongside 40 novel stimuli). Infants visited the lab twice (a median of 7 days separated lab visits). Computerized, monochromatic, animated geometric objects (e.g., stars, bells, hearts) were presented at one visit and rotating, multi-color toys (e.g., rattles, plastic beads, cars) were presented at a second visit (samples appear on Figures 1 & 2). A double-alternating stimulus pattern was used at each visit, with familiar stimuli appearing twice on the left side of the display and then twice on the right. Type of stimulus presented (geometric objects or toys) and where the familiar stimulus first appeared (left or right display) were counter-balanced across infants.

Individual looks at familiar or novel stimuli were coded off-line, and the time-series data were summarized into blocks of 4 trials. Four novel stimuli were presented within each block, appearing opposite the familiar stimulus. Looking-time averaged 25.2 sec per block (looking to novel plus looking to familiar stimuli; *SD*=5.0). Novelty preferences were computed per block as the percentage of total looking time aimed at novel stimuli, with a 40/60 split used to identify preferences. Group data (heavy black lines) and data for individual infants appear in Figures 1 & 2. Solid fine lines identify 28 sessions that began with novelty preferences of less than 40% (20.5% of sessions); dashed lines were used for the remaining infants. Familiarity preferences followed initial blocks with no novel or familiar preference in an additional 24 sessions (17.6% of sessions). Thus, 38% of sessions reflect patterns suggested by Hunter & Ames (1988). In contrast, 29 sessions started with a novelty preference lasting 1 or more blocks (21% of sessions); a familiarity preference appeared in later blocks in 5 of these 29 sessions. No familiarity blocks were found in 44 sessions (33%). Familiarity preferences were as likely to appear during Blocks 8-to-10 as Blocks 1-to-3 (18.9 vs. 14.5% of sessions). Expanded graphs better illustrating these various patterns and additional data comparing the performance of individual infants at the two visits will be presented on the poster (e.g., percent novelty for individual infants differed by an average of 9.3% between visits; time on-task was unrelated to percent novelty, etc.). In summary, variable looking patterns were found across infants throughout the first year when preferences were assessed with serial tasks. Interest in familiar stimuli, when calculated using 4-trial blocks, appeared throughout the session. While it is likely that brief familiarity preferences might be hidden within initial blocks, results indicate that infants do not simply shift from initial familiarity preferences to stable novelty preferences.

P2-F-329 - Disentangling how trait curiosity can explain individual differences in infants' active exploration

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Details

Only in recent years has infant curiosity become a focus of research and has provided insights into how infants actively engage in their own learning and have shown, that their learning history affects their continued engagement (Altmann et al., 2023; Kidd et al., 2012, 2014; Poli et al., 2020), that infants actively request information from adults through social orienting (Bazhydai et al., 2020) and pointing (Liszkowski et al., 2007), and indicated an association with learning and encoding benefits (Begus et al., 2014; Chen et al., 2022; Stahl & Feigenson, 2015). These studies assume that curiosity manifests itself in exploration and information sampling behaviors, for which many studies have reported individual differences (e.g., Bornstein et al., 2013; Mandler et al., 1987; Muentener et al., 2018; Piccardi et al., 2020; Slone et al., 2019; Smith & Yu, 2013; Wass & Smith, 2014). To this day, however, there was no way to investigate whether the individual differences in exploration behaviors were due to individual differences in the infants' underlying trait curiosity.
Here, we show this relationship for the first time employing the newly developed Infant and Toddler Curiosity Questionnaire (ITCQ) and its association to how 10-12-month-old infants structured their own exploration in a novel, gaze-contingent eye-tracking paradigm (Altmann et al., 2023). In this paradigm, infants could freely explore two novel categories by looking at either of two identical houses, thereby triggering the presentation of an exemplar from the respective category. In this way, they could repeatedly engage with the same category (exploitation) or switch to explore the other (exploration). It was previously found that three variables (overall engagement, switch-proportion, and category entropy) characterizing the self-generated exploration sequences grouped into three patterns of more explorative, exploitative, and balanced sampling.
In the current study, we focused on the sub-sample of more balanced explorers (N = 34, mean age = 11.2, SD = .50, 47% females) to see whether individual differences in their trait curiosity could explain variance in their exploration variables. Regression analyses showed that the relation between mean curiosity and overall engagement was best described as an inverted u-shape, so that infants with comparatively average curiosity scores triggered the most exemplars in this interactive study. In contrast, we found that mean curiosity positively predicted the infant's tendency to switch between categories in a linear manner. Lastly, we did not find a significant relation between mean curiosity and category entropy, that is, to which extend they exploited one or both categories. Together, these findings offer first insights into how differences in trait curiosity can predict specific characteristics of infants' active exploration.

P2-F-330 - Infants' statistical learning in social versus non-social stimuli

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Details

Infants are constantly bombarded with dynamic and unpredictable stimuli; how do they navigate the challenge of identifying patterns within the chaos? Many psychologists support the broad, multimodal theory of statistical learning, a cognitive mechanism that allows us to process relevant statistical information and make sense of our surroundings. For instance, within their first year of life, children utilize statistical information in speech streams to support their language learning (e.g., Juscyzk & Aslin, 1995; Saffran et al., 1996). However, other work has demonstrated surprising failures to utilize statistical information: In one study, 10-month-olds failed to anticipate the re-emergence of a smiley-face from behind an occluder if the smiley-face had emerged on two different sides probabilistically following a 70/30 ratio (Davis et al., 2011). One possibility is that infants perceived the smiley-face as a social agent, and did not use *patterns* to predict its re-emergence. In other words, given that infants expect *social agents* to act in consistent, goal-driven ways (e.g., Woodward, 1998; for review, see Robson and Kuhlmeier, 2016 and Elsner and Adam, 2020), they may less readily utilize statistical information to make predictions about social agents.

Across two pre-registered studies, we examined whether 7-month-old infants would differentially apply statistical learning to social versus nonsocial stimuli. Exp.1 adapted a visual prediction task from Reuter et al. (2018) to examine how infants use statistical information to update existing expectations. Thirty-four infants watched 8 familiarization trials in which a central fixation was consistently followed by a target stimulus appearing on one side of the screen. Then in subsequent test trials, the target instead appeared on the opposite side. Critically, for the Social condition, the target is a human face, whereas it is an object in the Nonsocial condition. We hypothesized that infants would more readily update their predictions in the Nonsocial condition, and thus show more anticipatory-eye-movements (AEMs) towards the new location relative to the Social condition. Results showed that infants in the Nonsocial condition showed relatively more AEMs towards the correct side (85%) than the Social condition (76%), but this difference was not statistically significant (two-tailed $t = 0.99$, $p = .33$).

Adapting Davis et al. (2011), Exp.2 examined infants' probability matching. Specifically, 34 infants watched a target move through the entrance of a Y-maze, then re-emerge on one of two sides. For all infants, the target emerged on both sides probabilistically following a 80/20 ratio. Similar to Exp.1, the target in the Social condition was a smiley-face as opposed to a ball in the Nonsocial condition. Results revealed that infants' proportion AEM mapped onto the 80/20 ratio in both the Nonsocial (84.3%) and Social (78.0%) conditions; however, AEMs patterns did not differ by condition ($p = .38$).

Overall, the studies found that infants did not utilize statistical information differently for social and nonsocial stimuli. At the conference, we will present results from exploratory analyses as well as additional conditions that follow-up on the suggestive trends observed in the current work.

P2-F-331 - Infants learned the prototype of other-race faces but not that of own-race faces

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Details

Human faces, as intricate and pivotal stimuli, play a crucial role in our social interactions. Essential to this interaction is the dual capacity to distinguish between individual faces and to recognize overarching similarities, such as kinship cues. Previous developmental studies have concentrated on infants' ability to differentiate faces, attributing this skill to perceptual experiences (perceptual narrowing, Maurer & Werker, 2014). However, the exploration of infants' ability to perceive commonality across faces (i.e., face prototype formation) has received less attention. The current study explored infants' ability to form face prototypes and examined how experiential factors contributed to its development by comparing own- and other-race faces.

Infants first watched a series of 12 faces (3 seconds/face) in the learning phase. These faces were created by morphing one unique face with a prototype face at a 50%-50% ratio so that these learning faces share perceptual commonalities with the prototype face. In the following test phase, we presented the prototype face beside a novel face (5 seconds for 2 trials). If infants learn the face prototype in the learning phase, they should treat the prototype face as familiar and show a preference for the novel face. Asian and White faces were used in separate blocks (within-subject design).

We conducted the study in the Spring/Summer of 2022 (Canada, n=24, White, 4-13 months, 14 females), the Spring/Summer of 2023 (Canada, n=25, White, 6-14 months, 13 females), and the Fall of 2023 (China, n=4, Asian, 8 months, 2 females). The experiments with the two Canadian cohorts were performed online, and their looking was coded manually. The Chinese experiment was tested in person with an eye-tracker.

Across the three cohorts, we found that infants learned the prototype of other-race faces by exhibiting a strong novelty preference (one-sample t-tests, $ps < .042$, Figure 1). In contrast, these infants failed to show any visual preference for own-race faces ($ps > .102$). The significant contrast between the other-race and own-race conditions (paired-sample t-tests, $ps < .013$) suggests that experience modulated infants' formation of face prototypes.

The contribution of experience is further demonstrated by correlations between age and the difference in novelty preference between the two face races (Figure 2). We found a positive correlation in the 2022 cohort ($r = .375$, $p = .05$) but a negative correlation in the 2023 cohort ($r = -.443$, $p = .03$). It is possible that stay-at-home measures due to the COVID-19 pandemic limited infants' exposure to a diverse type of faces in 2022, thereby amplifying the race-effect in prototype formation over age. As COVID-19 restrictions were lifted in 2023, infants were more likely to obtain face experiences of other races, which leads to a reduction in the race-effect.

In summary, this study, recruiting infants from diverse social and ethnic backgrounds, demonstrated a pronounced inclination in infancy to perceive similarities in faces of other races compared to those of their own race. The enhanced prototype formation for other-race faces may underlie the development of stereotypical responses towards individuals of other races later in life.

P2-F-332 - Maternal nutrition, SES, and early markers of infant neurocognitive development

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Details

Background

The first 1000 days of life are critical for neurodevelopment. Low socioeconomic status (SES) groups are particularly susceptible to environmental adversity during this window, with consequential lifelong impacts on neurocognitive development (Johnson, Riis & Noble., 2016). Increasingly, chronic inflammation is cited as a potential mediator of the relationship between LSES and poorer neurocognition, with nutrition a likely underestimated route through which this might manifest (Bordeleau et al., 2021; John, Black & Nelson., 2017).

Habituation and novelty detection, cited as precursors of early cognitive development, provide one accessible route for the examination of early neurocognitive development, with such indices associated with later executive functioning, language, and general cognition (Charlebois-Poirier et al., 2023).

Purpose

To understand the association between maternal dietary-based inflammation, SES, and early infant neurocognitive development in UK families.

Methods

Phase I: Nutrition and inflammatory blood markers were examined in 1,160 reproductive-aged women from the National Diet and Nutrition Survey (NDNS) using the Dietary Inflammatory Index (DII) (Shivappa et al., 2014). In Phase II the dietary-inflammatory markers identified from this national epidemiological dataset, are being used in the BRIGHT Project to examine their relation with early infant neurocognitive development. Neural and behavioural markers of habituation and novelty detection (HaND) are being examined in one-month infants using functional near-infrared spectroscopy (fNIRS) and the neonatal behavioural assessment scale (NBAS).

Results

Phase 1: Overall participants from the NDNS had pro-inflammatory diets (Median = 1.122, IQR = 1.416) (Figure 1).

Figure 1. Boxplot of DII scores from the NDNS dataset.

Multiple regression revealed significantly higher levels of log-transformed inflammatory blood marker, CRP, in women with more pro-inflammatory diets when controlling for BMI and health conditions ($\beta = 1.08$, $p < 0.001$). The final model accounted for 17.4% of the variance in CRP. A Welch two-sample t-test observed significantly higher DII scores in the lowest educational bracket (no qualifications, mean DII = 0.37) compared with the highest (degree level, mean DII = 1.5) ($t_{(df=176)} = -7.464$, $p < 0.001$). Similar trends were observed with CRP and education (no qualifications, mean CRP = 3.09; degree, mean CRP = 2.1) ($t_{(df=176)} = -3.953$, $p < 0.001$).

Phase 2: FNIRS data is being pre-processed and examined using Homer2 and a GLM design, to determine whether infants at one-month exhibited significant changes in their neural activity across a HaND task. NIRS data will be examined for correlations with NBAS habituation scores before being analysed with maternal DII using multiple regression.

Figure 2. Examples of infant neurocognitive developmental measures (NBAS: left and right; fNIRS: centre).

Conclusions

Pro-inflammatory diets may represent a route through which chronic inflammation manifests in reproductive-aged women, with higher instances of dietary-based inflammation in lower educational groups. Next steps aim to untangle the relationship of such variables with infant neurocognitive development.

P2-F-333 - Test-retest reliability in multivariate decoding of infant EEG data

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Details

Multivariate pattern analysis (MVPA) of EEG data can be used to quantify the way that information is represented in the brain by patterns of neural activation. MVPA is particularly useful when working with preverbal infant data, as these infants cannot communicate their mental states. MVPA can be used to quantify the pairwise representational distances between stimuli, generating a representational dissimilarity matrix (RDM). One benefit of this approach is the ability to compare representational distances generated from EEG data to those obtained from other modalities or models, such as specific layers of artificial neural network (ANN) models of human vision. However, what limits this approach is the extent to which representational distances can be estimated reliably, known as the “noise ceiling”.

To identify metrics of representational distance that maximize our ability to detect similarities between infant-derived and model-derived RDMs, here we sought to estimate the reliability of group-level RDMs obtained from infant EEG data. We are recruiting 12-15 month old infants and recording high density EEG while they passively view images of cats, dogs, faces, babies, bananas, trees, highchairs, and bottles. Using a linear support vector machine, the visual object conditions are classified based on patterns in the EEG data. Classification accuracy is then used as a measure of representational distance, based on the assumption that higher classification accuracy is driven by more distinct patterns of neural activity. Infant participants are invited to participate in two EEG sessions approximately two weeks apart. We take advantage of this two-sessions design to estimate the test-retest reliability of the group-averaged RDMs between sessions during the time window of highest classification accuracy (200-400 ms, Figure 1). Data collection for this study is currently ongoing. At each EEG session infants view the 16 images in randomized order over up to 15 blocks, for a maximum of 240 trials per session. When performing the decoding analysis, trials of the same object type were pooled (i.e. two different images of a dog are both classified as dog trials) resulting in 8 categories for classification. Using classification accuracy as the metric of difference, group average RDMs were calculated for session 1 and session 2 (Figure 2). First we defined a chance level by calculating the Spearman-Brown corrected Pearson's correlation with randomly shuffled data over 10,000 permutations. In our initial data set of n=8 infants, average reliability between sessions (Spearman-Brown corrected Pearson's correlation = 0.211) is slightly above chance (Spearman-Brown corrected Pearson's correlation = 0.168). The infants in this data set completed an average of 264 trials each, with an average of 16 trials per condition per infant. Reliability of the group-averaged RDM is expected to rise in the final, larger data set. Next we will extract RDMs from current ANN models of human vision (specifically VGG19, layer 4 and CORnet S, last layer) and compare them to infant neural representations. Ultimately we aim to clarify the relationship between infant visual object representations and representational information contained in ANNs in order to better understand human vision.

P2-F-334 - When do toddlers forget? Active forgetting across event boundaries

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Details

Although the raw material of perception is a continuous wash of stimulation—light on the retina, sensations on the skin, sound waves on our eardrums—we experience discrete events: the breakfast, followed by the shower, followed by one's morning commute. A great deal of work has now explored the boundaries between events because of their consequences for mental life.

In particular, previous work has identified many cues that facilitate event segmentation—from shifts in space from one room to another to shifts in one's tasks or goals. Events are typically defined through the lens of the Event Horizon Model (Radvansky & Zacks, 2017), at the core of which is the idea that we are constantly using current information to predict what will happen next. Thus, when environmental or

conceptual features change (e.g., changes in location or shifts in goal-oriented tasks), prediction error spikes, causing event models to update and giving rise to the subsequent experience of an event boundary (Radvansky & Zacks, 2017). Recent work has suggested that such updating may involve clearing older information from working memory — a mechanism of "memory flushing" (just as one clears a cache in a computer program; Ongchoco & Scholl, 2019). Though forgetting is often thought to be limiting (as a function of decay or interference), this more active sort of forgetting has been suggested to be adaptive, allowing the mind to release information that may have become obsolete due to situational changes.

Here we investigate whether memory flushing at event boundaries is present in 3-year-old children's relatively immature memory systems. We tested this phenomenon in the context of event boundaries created by spatial cues (Experiment 1) as well as shifts in goals (Experiment 2). In Experiment 1, participants remembered a set of 3 initial images, displayed sequentially. Then, they traversed a long room, where they could have either passed through a doorway (in the Doorway condition) or not (in the No Doorway condition). On the other side of the room, they were presented with the initial images sequentially once more, alongside 3 foils, and asked to identify which image they had seen initially. In Experiment 2, participants underwent the same initial and final memory tasks but completed a task with either one goal (in the One Goal condition) or two goals (in the Two Goal condition) in between. Participants' memory was assessed by the number of initial images they correctly identified (Figure 1).

In preliminary data (N=18) from Experiment 1, 3-year-olds showed worse memory in the Doorway condition (22.00%) compared to the No Doorway condition (52.33%), suggesting that memory flushing may occur early on in development. In the preliminary data from Experiment 2 (N=13), however, memory did not significantly differ across the Two Goal (50%) compared to the One Goal (33%) conditions, suggesting that at this stage in development, conceptual event boundaries may not suffice for triggering active forgetting in memory. Altogether, this work has the potential to elucidate the scope and power of event boundaries to structure when and how we forget over the course of development.

P2-F-335 - Infant error reduction: A gaze-contingent approach in A not B search tasks

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Details

The A not B error in infant search tasks, characterized by infants' failure to search for objects at new locations despite apparent knowledge of their whereabouts, has spurred extensive debate. Ahmed and Ruffman's (1998) study revealed that while infants often make A not B errors during search tasks, they also demonstrate an ability to recall the location of hidden objects in nonsearch contexts. This study aims to explore whether gaze-contingent methodologies could decrease A not B errors, thereby enhancing our understanding of the interplay among attention, memory, and motor control in early cognitive development.

Conducted at the Baby Research Lab, University of Tokyo, this study involved 11 full-term infants aged 10 months 3 days to 10 months 21 days (M age = 10 months 10 days). Participants completed both a

real-world A not B search task and a gaze contingency task, each with 18 trials (2 practice, 16 test). A 5-minute break separated the tasks, and a 3-second interval was provided from hiding the toy to the start of the search.

In the real-world task, infants interacted with two boxes and three toys. For the gaze contingency task, as illustrated in Figure 1, infants viewed visual stimuli mirroring the real setup. When infants gazed at the light-colored area on the screen for 1.0 second in the choosing phase, the corresponding box would open. Eye movements were tracked using the Tobii Spectrum, with stimuli response controlled via E-prime software based on the infants' gaze patterns. Throughout the task, including the break, infants were held in a forward-facing baby carrier by their parents and their behaviors were video recorded for detailed analysis.

For analysis, we compared the overall accuracy rates and the accuracy rates after the location shifts (A→B and B→A) between the real task and the gaze contingency task.

The analysis of the final data, which included 7 participants after excluding 4 due to insufficient selections in the gaze contingency task, distinct differences in accuracy rates were observed between the real and gaze contingency tasks. The gaze contingency task exhibited a higher average overall accuracy rate (M = 0.6505, SD = 0.2141) compared to the real task (M = 0.5, SD = 0.0807). In terms of accuracy rates following location shifts (A→B and B→A), the gaze contingency task also demonstrated an increased average accuracy rate (M = 0.3844, SD = 0.3418) compared to the real task (M = 0.2041, SD = 0.1996).

The primary objective of this study was to investigate the hypothesis that gaze-contingent methodologies would be more effective in reducing A not B errors compared to real tasks. Our results suggest that gaze-contingent methodologies indeed have the potential to minimize these errors, indicating a promising direction for future research in cognitive development.

Despite its promising results, our study's small sample size limits its broader applicability. To overcome this, we're planning a larger study with about 100 participants, aiming to confirm and enhance our findings, thus improving the reliability and effectiveness of gaze-contingent methods in cognitive development research.

P2-F-336 - Impact of facial expression on infant recognition of less familiar faces

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Details

Often, infants have predominant experience with women and individuals from a particular racial group (Rennels & Davis, 2008; Sugden et al., 2014). Discrepancies in experience are related to deficiencies in recognizing male and unfamiliar race faces (Kelly et al., 2007; Rennels et al., 2017). Evidence suggests 7-month-olds' face recognition is enhanced when familiarized to and tested with faces displaying emotional rather than neutral expressions (Gross & Schwarzer, 2010). This research examined whether

being familiarized to and tested with pleasant relative to neutral expression faces would improve infants' recognition of men and unfamiliar race faces.

Infants (*N*=114) aged 6-10 months (*M*=251.5 days) with predominant female (68%) and White (61%) facial experience provided usable data. Infants individually viewed four different videos of people (Black woman, Black man, White woman, White man) speaking nursery rhymes for 15s. Afterwards, infants saw the familiarized face presented among three other similar looking faces while a recording of the familiarized voice encouraged the baby to locate the face. It continued until the infant located and consecutively scanned the face for 800 ms (de Haan & Nelson, 1999) or 15 s had passed.

We examined whether expression, face gender, or face race affected infants' total fixations toward the face during familiarization. There was a main effect for expression, $F(1, 112) = 4.58$, $p = .035$. Infants made more fixations toward pleasant (*M*=9.38, *SE*=0.33) than neutral expression (*M*=8.39, *SE*=0.33) faces. There was also a main effect of face race, $F(1, 93) = 4.06$, $p = .046$. Infants made more fixations toward Black (*M*=9.36, *SE*=0.33) than White faces (*M*=8.42, *SE*=0.32). Infants directed a greater percentage of their fixations toward the internal features of Black (*M*=73.85%, *SE*=.02) compared to White faces (*M*=67.91%, *SE*=.02).

We then assessed how these variables affected infants' ability to locate faces and time to locate faces. There was an Expression x Face Gender interaction, $\chi^2 = 10.04$, $p = .002$. Infants more successfully located neutral than pleasant female faces but showed the reverse with male faces. The Expression x Face Race interaction was marginal, $\chi^2 = 3.00$, $p = .083$. Infants showed a slight advantage in recognizing Black faces with pleasant relative to neutral expressions. See Figure 1. For time to locate the faces, there was a main effect of face race, $F(1, 41) = 4.72$, $p = .036$. Infants more quickly located Black (*M*=6.13, *SE*=0.45) than White faces (*M*=7.54, *SE*=0.47), primarily because they were faster at locating pleasant Black faces compared to pleasant White faces, $t(41) = 2.79$, $p = .038$. See Figure 2.

Results suggest pleasant expressions facilitated infants' ability to recognize male and Black faces (i.e., the less familiar gender and race for the majority of infants). Positive expressions are more familiar to infants and they look more at positive relative to neutral expressions (LaBarbera et al., 1976). Such preferences might facilitate scanning of unfamiliar face types and subsequently enhance infants' face recognition. Findings have implications for understanding how familiar components of an interaction combine with unfamiliar components to affect infant responding.

P2-F-337 - Geometric content of visual form representations in 6-month-old infants

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Details

From infancy on, humans can discriminate between visual forms (e.g., Kayaert and Wagemans, 2010; Dillon et al., 2020). However, the geometric content of infants' form representations is currently unclear. Here, we probe the geometric content of 2-dimensional visual form representations in 6-month-olds. To analyze geometric content, we use Klein's Erlangen program, a framework unifying major mathematical theories of geometry and ordering them by degree of abstraction (Figure 1). One of the geometries of Klein's framework is Scale-free Euclidean geometry, which describes figures in terms of their proportions and angles, ignoring variations in position, orientation or size. The other geometries are either more abstract than Euclidean geometry (e.g., Projective geometry would ignore the differences between the shadows projected by a same contour) or less abstract (e.g. Identity geometry would consider two figures to be different even if they are related by a simple rotation). We conducted two preregistered experiments. The first one aimed at validating our paradigm using extreme geometric contrasts. Specifically, we assessed whether infants can discriminate between forms that are equivalent under all Klein's geometries vs. forms that are different under all these geometries. If they do, it proves that infants' perception has access to at least one of Klein's geometries. Our second experiment probed each geometry separately. In both experiments, we used the change-detection paradigm. Infants were presented with two streams of images showing forms for brief durations, on their left and on their right. On one side, all images displayed forms that were equivalent under a given geometry ("constant" stream), while on the other side, images alternated between two forms that were different under this same geometry ("changing" stream). If infants detect these changes, we expect them to look longer at the "changing" stream. Hence, we measured the log of the ratio of infants' total looking times at the "changing" vs. "constant" stream and compared it to 0. We used Bayesian statistics to be able to conclude either that infants do discriminate between the two streams, or that they do not. In our first experiment (N=12), infants were able to discriminate between streams showing forms that were equivalent under all Klein's geometries vs. streams alternating between two forms that were different under all these geometries (BF=81.11; Figure 2A), thus providing strong evidence that 6-month-olds' perception has access to at least one of Klein's geometries. Testing for our second experiment is ongoing (current N=78), and will continue until a BF>5 or a BF<0.2 is reached in each condition. Preliminary results (Figure 2B) suggest that 6-month-old infants' perception might have access to Identity geometry (i.e., two forms are different even if they are related by a rotation; BF=2.84) and Affine geometry (i.e., forms described in terms of alignment and parallelism, ignoring variations in position, orientation, size, or angle; BF=4.24). Nevertheless, 6-month-old infants might not be able to use Scale-free Euclidean geometry (i.e., forms described in terms of shape, ignoring size, position and orientation; BF=0.46) and Projective geometry (ignoring a range of variations, e.g. variations between shadows of a same contour; BF=0.47). As for Scale-sensitive Euclidean geometry (i.e., forms described in terms of shape and size, ignoring position and orientation), results are currently inconclusive (BF=1.00). As it stands, 6-month-old infants could have access to various geometric descriptions, and these varied representations of forms could constitute a rich foundation for learning school geometry.

P2-F-338 - Teaching enables preverbal infants to complete DCCS tasks

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Details

Miyake and colleagues (2000) initially identified three fundamental elements crucial to Executive Function (EF): inhibition, working memory updating, and shifting. The Dimensional Change Card Sort (DCCS) tasks (Zelazo, 2006), commonly used to measure EF, often result in 3-year-olds making perseverative errors and failing in the post-switch phase. However, young children also can be significantly influenced by observing someone else complete the task (Moriguchi et al., 2007), indicating that teaching participants beforehand might help alter their understanding and application of objects' dimensions.

In terms of teaching methods, evidence suggests that visual attention effectively shapes young children's understanding of rules (Cheng et al., 2019; Johnson et al., 2003). Additionally, combining visual attention with a relatively new cognitive measurement tool—Gaze Contingency avoids situations where young participants (e.g., 1-year-olds) may comprehend the physical meaning of shapes and colors but lack verbal understanding. Therefore, we developed a novel gaze-contingent eye-tracking paradigm that allowed infants to engage in DCCS tasks by directing their gaze toward objects on the screen.

Our experiment was divided into pre-switch and post-switch phases, which involve teaching and testing for rules respectively (Figure 1A). We tested a total of three colors and shapes of objects (Figure 1B). During the teaching, a target was displayed at the center for 2000 milliseconds, and an object in the same shape/color as the target (Figure 1C) appeared next. When the participant maintained fixation on the second object for 300 milliseconds, a 'ding-dong' sound accompanied the lighting up of the button for 1200 milliseconds (with a maximum waiting time of 5000 milliseconds). This procedure aimed to guide participants in building rule association through visual attention. In contrast to the teaching, during testing, two objects in different dimensions were simultaneously presented after the target, and the correct cues appeared only if the infant fixated on the object corresponding to the rules taught before. Besides, to examine the impact of teaching, the control group did not receive Rule 2's teaching but observed a visual attention connection between two unrelated objects (eg. a red heart and a blue cross). Participants underwent a total of 10 trials in both teach and test parts. We balanced the order of color and shape rules among different participants.

The pilot experiment indicates that among 12-month-olds (N = 12), distinct reaction time differences (RTD = RT_{Rule2} - RT_{Rule1}) were observed in the two groups. Compared with the pre-switch phase, during the post-switch phase, the teaching group spent less time searching for the target (RTD = -85.41ms), but the control group spent more time searching (RTD = 639.07ms). Remarkably, the performance of 1-year-olds resembled that of 2 and 3-year-olds in terms of dimensional changes (N = 6, $RTD_{teaching}$ = 189.16ms, $RTD_{control}$ = 1353.11ms)(Figure 2). These findings suggest that even preverbal infants could comprehend the dimensions of shape and color and make dimensional shifts under guidance. Hence, this research provides preliminary evidence of teaching's influence in aiding young children to complete DCCS tasks before their EFs fully mature.

P2-F-339 - Visual Rule learning skills at 3 months: the role of spatial orientation and working memory load

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Details

Visual rule learning – the ability to discern and generalize high-order rules from visual sequences – has been extensively documented in infants aged 7 months and older (e.g., Rabaglaiti et al., 2019). However, only one study has demonstrated this ability in younger infants, specifically 3-month-olds (Ferguson et al., 2018). Previous research has shown that visual rule learning in 7-month-old infants is influenced by the spatial orientation (left-to-right vs. right-to-left) of the sequences presented on the screen (Bulf et al. 2017) and the complexity of the rule (ABB vs. ABA; Johnson et al., 2009). Here, we aimed to replicate and extend previous findings of visual rule learning in 3-month-old infants. We investigated whether: (1) working memory load affects the extraction and generalization of the rules embedded in visual sequences; and (2) the directional bias observed in older infants is present at this younger age. To this end, three studies employed an infant-controlled habituation paradigm with 3 month-old infants, who were habituated to visual sequences following a specific rule (e.g., ABB) and were then tested with novel sequences alternating between the familiar (ABB) and a novel rule (e.g., ABA). Infants' looking times toward the novel and familiar visual sequences were compared to assess their ability to discriminate between the two rules.

We systematically manipulated the temporal structure (sequential vs. simultaneous sequence presentation), the rule complexity (ABB vs. ABA), and the spatial layout of the sequences (left-to-right vs. right-to-left) (Fig. 1). In Study 1, left-to-right ABB sequences were presented either sequentially, with one item following another and each item occurring one at a time, or simultaneously, with one item following another, each remaining visible on the screen for the entire duration of the triplet presentation. Results (Fig.1) indicated that infants successfully discriminated the novel sequence at test only when the ABB rule was presented simultaneously, not sequentially, on the screen. In Study 2, infants were habituated to either left-to-right ABB or ABA simultaneous visual sequences, and novelty discrimination at test occurred only after habituation to ABB. Finally, in Study 3, ABB triplets were presented simultaneously, either from left to right or right to left, and infants succeeded in extracting and generalizing the rule in both spatial layout conditions.

These findings suggest that reducing working memory load facilitates rule-like structure extraction and generalization in 3-month-old infants. Unlike older infants, the spatial orientation of the sequences did not affect this ability. The results will be discussed for their implications in comprehending the developmental origins of directional biases in order-space mapping.

P2-F-340 - Effect of object visual image on tool selection—Children' tool-based scale error—

Mikako Ishibashi [1], **Yusuke Moriguchi** [2]

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Details

Children sometimes showed interesting behaviors as if they do not consider actual size of objects. This behavior is called scale error (DeLoache et al., 2004). Previous studies indicated that children executed the inappropriate behavior (e.g., try to ride on the miniature car) due to the inhibition of the evoked image of the full-size object when seeing the miniature-size object (Grzyb et al., 2019). The mechanism behind scale error is due to the failure to suppress the dominant full-size object representations induced by visual images of miniature-size objects. Ishibashi and Moriguchi (2021) examined children's tool-based scale error where an inappropriate size tool selection to an apparatus when they were presented the appropriate and inappropriate sized tool simultaneously by using NIRS. Their results showed that children' prefrontal region was significantly more activated when they were required to select the appropriate sized tool than when they were not, suggesting that scale errors may be associated with the inhibitory control in the prefrontal cortex. In this study, we examine whether children's tool selection is influenced by visual images of tool use that a model presented. In particular, we compared children' tool choice after observing the manipulated an appropriate or inappropriate sized tool into the apparatus. Given that the children' scale error may be due to the immature inhibition of activated inappropriate size information, children with scale error have weaker prefrontal activation than those who without scale error. Moreover, children would be required to be more inhibitory control as they need to inhibit the object image which the tool was used inappropriately when they observed the inappropriate tool/apparatus use compared to the appropriate tool/apparatus use.Children were shown either one of two video clips; a model manipulated an appropriate size of tool into an apparatus (Correct condition; *N* =10, *range* = 28-58 months; *Mage*= 39.4months) or an inappropriate size of tool into an apparatus but failed to use in the end (Incorrect condition; *N* = 17, *range* = 26-51 months; *Mage* = 41.18months). After watching the either video, children were given two sizes of tools; one was size-appropriate and the other was size-inappropriate, and they were required to play using the tool. The session was terminated when the four trials were complete. We observed children' tool selection and activation of the prefrontal cortex. We used a multichannel NIRS unit operating at wavelengths of 770 and 840 nm (OEG-16; Spectratech Inc., Tokyo, Japan) to measure temporal changes in the concentrations of oxygenated hemoglobin (oxy-Hb). The NIRS probe included 12 optodes, which constituted 16 channels, and the probes were placed on the prefrontal areas of each hemisphere. Currently data collection is undergoing, we do not analyze data statistically. The results showed that the prefrontal activation during the task was increased children who do not exhibit scale error (SE) than those who exhibit SE in both conditions (SeeTable1). Of the data in children with scale error, prefrontal activation was more active in the incorrect condition than the correct condition, suggesting that the incorrect image maybe required to inhibit children' behavior than the correct image. These results suggest that action selection of children who exhibit scale errors may be strongly influenced by the evoked object representations right before they were seen. Our results indicated that children' scale error may be related to immaturity to inhibit the visual image immediately presented.

P2-F-341 - Color Categorization in Infants and Adults: What is it good for?

Micalee Segers [1], **Tori Jones** [2], **Shannon Ross-Sheehy** [2]

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Details

Although color falls on a spectrum, humans perceive color categorically; when presented with intermediate colors (bluish-green) adults perceive either *green* or *blue*. This categorical perception facilitates performance for between-category contrasts compared to within-category contrasts in infants and adults (Ozturk et al., 2013). For example, infants were faster to fixate on a green circle on a blue background, compared to a green circle on a bluish-green background (Franklin et al., 2005).

Though categorical perception has been demonstrated in infants, most of these studies were conducted using the exact same color boundaries and values, calling the robustness of this phenomenon into question. In addition, the current task goes one step further, directly testing the utility of categorical perception for edge detection and acuity. To accomplish this, we implemented a novel color acuity task. This task was modeled after the Teller Acuity Task, only rather than showing infants black and white gratings, infants were shown isoluminant color gratings creating using between-category (blue and green), and within-category (blue and greenish blue) color contrasts. Gratings were created across two different color sets (blue and green), and infants were assigned to either the green set (green within-category contrasts, blue/green within-category contrasts) or the blue set (blue within-category contrasts, blue/green within-category contrasts). Eye-tracking was used to assess grating detection, and the spatial frequency of the gratings increased in difficulty until the infant failed to fixate it within 2s, allowing for both assessment of acuity (max cycles per degree) and detection speed (latency). LME models were used to assess acuity and latency in infants and adults.

Results for infant latency revealed no significant effects (all *ps* >.1). Infant acuity results were mixed, revealing a significant three-way interaction for condition, color group, and age, β_{est} = 6.1653, t = 2.048, p < .05, suggesting an asymmetric influence of color set. An examination of the estimated marginal means revealed that 7-month-old infants in the green condition had higher acuity when viewing between-category trials (*EMM* = 6.568, *SE* = 1.380) compared to 7-month-old infants in the blue conditions (*EMM* = 4.545, *SE* = .765). In contrast, 7-month-olds in the blue condition had higher acuity for within-category trials (*EMM* = 3.776, *SE* = 1.433) compared to the between-category trials (*EMM* = -3.661, *SE* = 1.542; Figure 1).

Adult latency results were similarly puzzling, revealing a significant main effect of Condition, β_{est} = -67.86, t = -2.616, p < .001, and a significant Condition by Color interaction, β_{est} = 181.81, t = 3.505 p < .001 (Figure 2). Post-hoc comparisons revealed that participants who viewed green stimuli were significantly faster at finding the target for within-category (*EMM* = 407, *SE* = 49.9) as compared to between-category contrasts (*EMM* = 566, *SE* = 52.5). Adult acuity results revealed no significant effects (all *ps*>.1).

Overall, results were mixed, providing only limited evidence of categorical perception in infants and adults. Full model explorations and a discussion of limitations will be discussed in the poster.

P2-F-342 - What is novel in novel object exploration? Moment-to-moment changes in the dynamics of parent-infant interactions during familiarity versus novelty exploration

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Details

Parents' adaptation of their parenting practices to various contexts and contingent responsiveness play a crucial role in children's exploration – a key element of early curiosity (Caporaso et al., 2022). The introduction of a novel stimulus might be a critical moment for parents to boost their infants' curiosity (Kidd & Hayden, 2015). Yet, there has been no systematic investigation of changes in parent-infant interactions when novelty is introduced. Thus, we tested (1) if caregivers tailor their parenting behaviors based on infants' prior knowledge of stimuli, and (2) whether these parenting behaviors have varying impacts on infants' contingent exploration when exploring familiar vs. novel objects.

Thirty-nine infants and toddlers (*Mage*=16mos) and their mothers participated via Zoom. Participants were mailed 4 familiar toys (e.g., a plastic ball) and 1 novel toy intended to elicit infants' curiosity (a knotted foam curler). Caregivers played with their infants with familiar toys for the initial 5 minutes (*familiarity-exploration phase*). For the next 5 minutes, they were prompted to introduce the knotted curler and continue playing (*novelty-exploration phase*). To compare parent-infant interactions during the two phases, we coded their behaviors surrounding two perceptually matched objects: the yellow ball during the familiarity phase, and the yellow curler during the novelty phase.

Parent and infant behaviors were coded separately using our newly developed coding protocol (Table 1). Each phase was divided into 5-sec intervals, and the occurrences of behaviors shown in Table 1 were recorded during each interval. Infants spent 19% of playtime exploring the ball during the familiarity phase, and 22% exploring the curler during the novelty phase (p>.05). Overall, caregivers showed similar patterns of behavior during the two phases (Fig 1A).

Despite the overall similarities in both infant and caregiver behaviors, the contingencies between these behaviors changed based on the novelty of stimuli. We examined whether the probability of infants' exploration increased as a function of different caregiver behaviors during each phase separately. Infants' exploration was identified as contingent on a caregiver behavior if it occurred in the 5-sec interval following the caregiver behavior. The conditional probability of contingent exploration was compared to a 50% probability (i.e. chance). Preliminary analyses (n=30 of 39 infants) showed that both infants' familiarity and novelty exploration increased following caregiver's observation (p<.01). In contrast, both types of exploration decreased following caregiver's non-verbal promoting and distraction behaviors (ps<.01). Interestingly, we observed an interaction between caregivers' disrupting behavior: Disruptions led to *decreased* familiarity exploration (p<.01), but *increased* novelty exploration (p=.07).

The current study suggests that parents' autonomy-supporting behaviors (observations), might be the most efficient way of boosting infants' immediate exploration in brief play. Furthermore, our comparisons of contingent interactions suggest the same parenting behavior might have different consequences for infant exploration depending on the level of stimulus novelty – this nuance cannot be captured solely by comparing general patterns of interactions. Together, our new findings highlight the importance of micro-level analysis in parent-infant dynamics, and provide new insights into factors that support the early development of curiosity-driven behaviors.

P2-F-343 - Successful re-sensitization of 2.5-year-old children to other-race faces

Özlem Sensoy [1], **Anna Krasotkina** [2], **Antonia Götz** [3], **Barbara Hoehle** [4], **Gudrun Schwarzer** [5], **Özlem Sensoy** [1]

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Details

During the first year of life, infants undergo a rapid development in perceptual abilities, a phenomenon known as perceptual narrowing (Kelly et al., 2009; Kelly, Quinn, et al., 2007). While infants exhibit heightened discriminatory abilities towards frequently encountered stimuli such as own-race faces, the same declines for rarely encountered ones, such as other race faces (Clerc et al., 2022; Kelly et al., 2009; Krasotkina et al., 2018, 2021; Pascalis et al., 2002). This reduced sensitivity to other-race faces is known as the Other-Race Effect (ORE). Even though the effects of the ORE have been shown to be long-lasting, infants' discriminatory abilities remain adaptable (e.g. Clerc et al., 2022; Krasotkina et al., 2021). For instance, Krasotkina et al. (2021) successfully re-sensitized 12-month-olds to other-race faces by familiarizing infants with a bimodal distribution of morphed Asian faces at an age where infants typically show reduced sensitivity to such faces. Beyond infancy, however, studies investigating the reversibility of the ORE are missing. Therefore, in our study, we investigated the potential for re-sensitizing 2.5-year-old Caucasian children to other-race faces beyond the typical onset of the ORE.

Our final sample consisted of 21 children aged 2.5 years old (8 female). We familiarized children with a bimodal distribution of a morphed continuum of Asian female faces with faces closer to the endpoints of the continuum presented most frequently (see Figure 1). We assessed children's discrimination of Asian faces by measuring their looking times after the familiarization phase. We used the endpoint faces both as prime and test faces in match and mismatch trials. In the match trials, prime and test faces were identical while in the mismatch trials, prime and test faces differed. Prior to our main analysis, we checked whether children were able to differentiate between the two endpoint faces prior to the familiarization phase. The paired *t*-test (two-tailed) showed no significant difference between match and mismatch trials, $t(20) = -.69$, $p = .501$. The 2.5-year-olds looked equally long in the match ($M = 6.76$ s, $SD = 2.41$s) and mismatch trials ($M = 6.20$ s, $SD = 3.22$ s).

For our main analysis, we conducted a paired *t*-test (two-tailed) with the looking times in match and mismatch trials. The *t*-test revealed a significant difference in looking times between match and mismatch trials, $t(20) = -2.92$, $p = .008$, Cohen's $d = -0.60$ (see Figure 2). The 2.5-year-olds looked longer in the match trials ($M = 5.06$ s, $SD = 3.32$ s) compared to the mismatch trials ($M = 3.30$ s, $SD = 1.98$ s), indicating that they were able to successfully discriminate between the Asian faces after the familiarization.

These findings demonstrate that children can be re-sensitized to other-race faces through exposure to a bimodal distribution of such faces even after the onset of perceptual narrowing, highlighting the plasticity of face perception in childhood. Importantly, our study contributes to a deeper understanding of the developmental dynamics of perceptual narrowing, suggesting that exposure to diverse stimuli exemplars can counteract the effects of perceptual narrowing.

P2-F-344 - Check this out: The role of visual saliency in attention during a naturalistic task from infancy to adulthood.

Astrid Priscilla Martinez Cedillo [1], **Quoc Vuong** [2], **Elena Geangu** [3]

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Details

Visual scenes contain salient regions, i.e., a region with bright, colourful objects, that can capture attention. Some studies suggest that the attention to salient regions changes with age (Amso et al., 2014; Renswoude et al., 2019). Albeit, Kadooka and Franchak (2020) report contrasting results. One possible explanation for these apparent discrepancies in findings may be related to the variation in the type of stimuli (i.e., dynamic vs. static; simple geometric shapes vs. complex scenes), questioning their generalisability. As computer-presented stimuli are used in these studies, questions arise regarding their ecological validity and whether they can explain infant attention during everyday situations occurring in their natural environment. In the present study, we aimed to address these issues by investigating infants' guided search in environments similar to their everyday life. Infant (6-, 9-, 12-, 24- and 36-month-old) and adult participants (N=72; 12/age group) wore a head-mounted eye-tracker whilst performing a name-object task in an open play area. During the task, the researcher pointed to or held out six objects distributed across a cupboard (Figure 1). We then compared participants' fixations to model observers driven by visual saliency (Figure 2) to examine whether it affects visual attention, and how saliency effects change with age. Following previous models (Itti & Koch, 2001), we took the centroid of the first most salient region (i.e., fixation) per frame across the video recorded during the task and calculated the distance to participants' gaze. Preliminary results showed that the youngest infants, ages 6- and 9-month-olds, had shorter distances to the models' fixations than the oldest infants and adults. Furthermore, younger infants attended more to salient regions early in the video, whereas older infants and adults attended more to salient regions later in the video. These findings suggest that the temporal dynamics of the fixation pattern relative to the perceptual salience in the visual scenes change with age, and offer valuable insight into how infants and adults process visual information, particularly when top-down and bottom-up mechanisms compete to guide attention. Additionally, this research expands upon previous studies conducted in controlled lab environments by observing individuals' natural visual behaviour in unrestricted, real-world settings.

P2-F-345 - Investigating the effects of audio cues on infant orienting of visual attention

Stacey Stuart [1], **John Spencer** [1]

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Details

Research has demonstrated significant associations between early infant visual attention and later cognitive outcomes such as reading proficiency and language learning (Hendry et al., 2019). Moreover, atypicalities in infant visual attention have been linked to neurodevelopmental disorders such as autism spectrum disorder (ASD; Elsabbagh et al., 2013; Richards & Lajiness-O'Neill, 2015) and attention deficit hyperactivity disorder (ADHD; Atkinson & Braddick, 2012). These associations demonstrate the critical role infant visual attention plays in development. Therefore, an understanding of the onset and development of visual attention is essential.

Studies of infant visual attention have demonstrated strong effects of spatial cuing whereby peripheral cues help to facilitate the speed and accuracy of visual orienting when cues are valid yet hinder speed and accuracy when invalid (Ross-Sheehy et al., 2015). These cuing effects are modulated by infants' ability to disengage from a central stimulus and redirect visual attention to a target. Here, the presence of visual competition slows infants' reactions times; in doing so, we see an increase in accuracy (Spencer et al., 2022).

An important question is how these cueing and competition effects are modulated by other cues such as auditory input. According to Peter & Posner's (2012) neurocognitive model of attention, auditory input might serve as an alerting cue, enabling infants to better process spatial cues in the presence of a tone? Alternatively, tones might interfere with visual processing of spatial cues, consistent with theories of auditory overshadowing (Robinson & Sloutskey, 2019).

To investigate this, we used an adaptation of the IOWA task (Spencer et al., 2022), creating both a tone and no tone version. 70 Infants (34 male) aged between 4.5- to 10.5-months were pseudo-randomly allocated to either the tone (n = 35) or no tone (n = 35) version of the task. Eye tracking was used to measure infants' reaction times and accuracy when looking to targets across all cue/competition trial types (84 trials total, see figure 1 for trial types and the sequence of events on each trial).

Results revealed that there were no significant effects of tone on infants' speed or accuracy of visual attention; thus, our findings neither lend support to the idea that the tone is a cue to the alerting network, nor the idea that the tone overshadows visual processing. Results did however replicate the cueing and competition effects as observed in previous studies (Ross-Sheehy et al., 2015; Spencer et al., 2022). Our findings, therefore, attest to the robustness of the IOWA paradigm. Further, our findings suggest that the tone has little impact on performance. As omitting the tone from the task reduces the total number of trials infants must complete, our findings suggest an easy way to simplify data collection in future studies by eliminating the tone and the associated tone-only condition.

P2-F-346 - Testing 12-month-old infants' evaluation of expected information gain in a gaze-contingent paradigm

Bálint Varga [1], **Gergely Csibra** [1], **Barbara Pomiechowska** [2], **Agnes Kovacs** [1]

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Details

Although there is a growing body of research on how infants' observational behavior may be sensitive to the amount of information they gained in the past (Kidd, Piantadosi, & Aslin, 2012, 2014; Poli, Serino, Mars, & Hunnius, 2020), it is unclear if their behavior is also directed by forward-looking evaluation of information, such as expected information gain (the average expected reduction of uncertainty due to attending to an information source). In an eye-tracking paradigm, we investigated 12-month-olds' ability to actively use information sources by controlling on-screen events with their gaze. In each trial, participants were presented with three closed boxes (A, B, C), each potentially containing a character. By fixating on two laterally positioned buttons, infants could "shake" two different, partially overlapping pairs of boxes (A and C, or A and B), thereby gathering auditory cues about these boxes' possible contents before they were opened (Figure 1). We hypothesized that infants would shake box pairs in line with maximizing information gain about character locations.

We ran two pre-registered experiments with different underlying probability distributions for character locations. In Experiment 1 (N=36), the distribution was uniform (A: 1/3, B: 1/3, C: 1/3), rendering the shaking of both box pairs equally informative until the last six trials, when one of the boxes (C or B) was initially revealed to be empty, rendering one of the box pairs suddenly more informative. Infants showed a significant increase in decision onset time (β=33.74, p=0.046) and in the likelihood of anticipations across trials (for each successive trial, the odds of anticipation increased by about 9%, p=0.002), suggesting that they learned the task-relevant contingencies. However, contrary to our hypothesis, participants were significantly more likely to choose the uninformative button (V=61.5, p=0.002; Figure 2). These results do not align with maximizing expected information gain, but they are congruent both with maximizing the probability of auditory cues and confirmatory hypothesis testing.

Experiment 2 (planned sample size N=36) employs a non-uniform probability distribution for character locations (A: 11/24, B: 9/24, C: 4/24; this particular distribution is based on prior simulations of the ideal observer models following the three discussed strategies) to differentiate between these three strategies and to rule out alternative explanations of our previous results. In this setup, one box pair (A and C) becomes consistently more informative about the current character location before any box is eliminated, while the other (A and B) provides confirmatory evidence. Data collection is in progress and results will be presented at the conference.

P2-F-347 - A novel approach to testing for altercentric interference vs. bias in young infants

Velisar Manea [1], **Dimitrios Askitis** [1], **Emanuela Yeung** [1], **Victoria Southgate** [1]

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Details

We employ a modified smurf task (Kóvacs et al., 2010) that affords more detailed predictions for the altercentric bias (Manea et al., 2023; Yeung et al., 2022; CG Wiesmann et al., 2022).

Usually, a group of infants is presented with one pair of conditions. For controls, an agent (A) sees the same last event as the participants (P), either a ball leaving the scene (P-A-) or ending up in the scene, behind the sole occluder (P+A+). A control is paired with an experimental condition where the agent sees only the next-to-last event (P-A+ or P+A-, the latter untested with infants so far), and the question is

whether infants' expectations are contaminated by the agent's outdated information on the ball's location.

Ideally, all four conditions would be within-subjects This would allow us to test a more granular prediction for infants' expectancy violations: P+A+ > P-A+ > P+A- > P-A-. That is, we expect compounding effects when the agent sees the same actions (P+A+ & P-A-) as well as a congruent outcome more surprising than an incongruent one (P-A+ > P+A-).

Achieving a realistic sample size with four conditions requires maximising the valid data collected per participant. We built an infant eye-tracking system from the ground up that allows us to add pupillometry to looking time studies without altering the experimental layout. We are able to run a 'relive' of the session with different algorithm parameter values if the initial data are too noisy. We currently have data from 100% of the infants tested (*n* = 34) and we were able to run 12 trials per participant with most infants.

We will present the new system, a preregistration strategy that obviates the need for piloting (https://aspredicted.org/6z7au.pdf), and the study final results.

P2-F-348 - Can we see the wheels turning? Pupillometry as a measure of processing involved in covert attentional shifts

Tori Jones [1], **Micalee Segers** [2], **Shannon Ross-Sheehy** [1]

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Details

The visual world contains more information than our visual systems can process. Thus, visual attention reduces our processing needs to the attended stimuli. Typically, viewers direct their eyes towards the item of their attention (*overt* attention). However, prior to moving our eyes, attention first redeploys resources to a new spatial location, presumably to facilitate the eye movement (*covert* attention; Johnson, 1994). This *covert* attention is typically followed by *overt* attention as the eye movement brings that object to the central field of vision.

Spatial cueing tasks have often been used to assess covert attention shifts by presenting subjects with a small spatial cue to the left or right of fixation. This precue is thought to elicit an automatic shift of covert attention, so subjects are faster to detect targets presented in the same location as the cue, and slower to detect targets opposite the cue (spatial cueing effect). Though previous research has demonstrated strong spatial cueing effects in infants (Ross-Sheehy et al, 2015), these tasks have relied on overt attention shifts rather than covert attention shifts. Thus, the current aims are to demonstrate the utility of pupillometry as a means of assessing covert attention and to determine how covert attention changes with development.

To accomplish this, 5-, 8-, and 11-month-old infants and adults (N=100) participated in a spatial cueing task (Ross-Sheehy et al., 2015) while gaze from both eyes was continuously tracked (300Hz). Each trial began with a dynamic central fixation stimulus to elicit attention. This was followed by a small gap

(50ms), then a brief 100ms spatial cue to the left or right of fixation (small black dot), then finally a target to the left or right of fixation. This target is either in the same location of the spatial pre-cue (valid cue) the opposite side (invalid cue) or on both sides (double cue). Linear mixed effect models were used to compare all test conditions to a tone cue baseline condition (*Fig1*). Dependent measures included latency to orient to the target (LTO) and pupil diameter (PD).

Pulling from adult literature (Koevoet et al., 2023), we hypothesized that covert attention would produce a rapid pupil dilation prior to an eye movement, and further hypothesized that larger pupil changes would proceed faster eye movements. Preliminary results revealed significant pupil *contraction* for valid cues (b_{est}=-90.95, p<.001) and significant pupil *dilation* for invalid cues (b_{est}=105.29, p<.001; *Fig1)* when compared to a tone cue baseline. Double cues did not vary from baseline. Results also revealed a significant effect of age, with significantly more pupil *contraction* with increasing age (b_{est}=-24.20, p<.001). Linear model results examining the relation between LTO and pupil dilation was significant, F(1, 3,483)=36.83, p=>0.001, *adj* R^2=.010, though the effect was opposite our hypothesized direction: Pupil *contraction* was associated with faster orienting times (*Fig2*). These results suggest pupillometry may be useful for examining covert orienting effects, though results are complex. Final poster will include a full analysis of infants and adults.

P2-F-349 - Mechanisms for translating short-term perceptual changes in infancy into long-term developmental changes

Zahra Abolghasem [1], **Fengting Yan** [1], **Lauren Emberson** [1]

[1] University of British Columbia

Details

While an infant has access to their senses, their perceptual system is, initially, only able to make limited sense of their world. Their perceptual system develops gradually, in part, because of their sensory experiences. Interestingly, the perceptual system of infants can be rapidly and flexibly influenced by their short-term experiences. An example of this has been shown by Xiao and Emberson (2023) who demonstrated that briefly learning that an audiovisual cue is associated with a direction of motion is enough to alter an infant's motion perception. While these short-term perceptual changes can emerge rapidly, it is unknown whether and how these short-term perceptual adjustments give rise to longer-term, developmental changes. Previous research on perceptual learning in adults has found that dispersed training procedures, that reactivate the memory of the initial experience, have been tied to long-lasting perceptual changes (Song et al., 2021). However, no corresponding work has been done in infants to investigate the mechanisms that operate in infancy to give rise to long-term perceptual changes. We have established a training procedure to investigate whether reactivating the initial learning experience can support long-term retention of perceptual changes in 6- to 8-month-olds. We will use a multi-session paradigm with five sessions, each session occurring once a week. During the initial session, infants will learn that specific audiovisual cues are associated with a direction of motion (either leftward or rightward) on 75% of trials. The motion will elicit smooth pursuit eye movements, which are specialized eye movements that track motion at its direction and velocity, to provide a trial-by-trial measure of visual motion perception. As a sign of perceptual change, we will determine whether the learned audiovisual cues, followed by random motion, will elicit smooth pursuit eye movements that

correspond to the directional motion predicted by the cue. Following the initial session, we will have one group of infants (experimental) complete brief training sessions that reactivate the memory of the initial learning experience, as well as another group of infants (control) complete training sessions that are of similar length to the initial learning experience. The study will compare smooth pursuit eye movements of the memory reactivation group to the full exposure group during trials with random motion in the first and last (5th) sessions to investigate the role of memory reactivation in the long-term retention of perceptual changes. The study will demonstrate 1) whether short-term perceptual changes can persist for long periods of time and 2) whether large amount of experience is needed or if repeated brief exposure, that allow for memory reactivation, is sufficient to produce long-term, developmental change. This pre-registered research (https://osf.io/abxhy/?view_only=bb7a255f5838464d9d19c3a4ce232226) will provide insight on the mechanisms that translate day-to-day experiences into the development of perceptual systems.

P2-F-350 - Nine-month-old infants discriminate bodies on the basis of identity information but only with upright and headless bodies

Emma Axelsson [1]

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Details

Infants discriminate facial identities early in the first year and there is mounting evidence of their ability to discriminate bodies based on structure, size of body parts, and even attractiveness. However, there are no known studies of infants' discrimination of bodies on the basis of identity. When facial information is obscured, can infants recognise identities from bodies alone? Six and 9-month-old infants saw pairs of faceless identities in upright and inverted orientations to assess for an inversion effect. In adults, the body inversion effect is diminished when heads are absent. Thus, to determine the role of heads, headless figures (bodies without heads) and whole figures (bodies with heads) were presented. In each condition, infants were familiarised to an identity, which was subsequently paired with a novel identity. Looking times to the images were measured using eye tracking and novelty preferences to the novel identity were calculated in each condition (upright headless, inverted headless, upright whole figure, and inverted whole figures). The 6-month-old infants' preferences for the novel identities were at chance level in all four conditions, but the 9-month-old infants demonstrated a significant preference for the novel identity only when the bodies were headless and in an upright orientation. Eye tracking data revealed that infants' looking proportions to bodies were longest in the headless upright condition. Despite the absence of facial features, looking to heads was longest in the upright whole figure compared to the inverted whole figure condition. Infants also looked longer at the feet of inverted stimuli compared to the upright stimuli suggesting that infants have an upper bias when presented with human figures. The findings suggest that at 9 months of age, infants can recognise identities on the basis of bodies, but only in the absence of head information, and when bodies are in their typical orientation. Heads support adults' body discrimination, but are instead a source of distraction for infants.

P2-F-352 - The flexibility of early information-seeking: do infants adapt their search for information to the adult's domain of competence?

Maria Mavridaki [1], **Agnes Kovacs** [1]

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Details

Infants engage actively in social learning, displaying behaviors that elicit information transfer from adults, such as pointing (Kovacs et al., 2014, Begus and Southgate, 2012) and social referencing (Bazhydai et al., 2020). They also show selectivity in whom they learn from, preferring competent, rather than incompetent partners (e.g. Zmyj et al., 2010). However, communicative partners are rarely fully competent or incompetent, instead their competence depends on the domain being considered. Indeed, by 3 years of age, children distinguish between adults with different expertise and they refer to the most appropriate informant to acquire domain-specific information (e.g. Lutz and Keil, 2002). Nevertheless, it is unclear whether infants are already sensitive to different domains of competence and whether they flexibly adapt their information-seeking behaviors to the competence and knowledge (or lack thereof) of their partner. To this end, 18-month-olds were presented with two informants (E1,E2) and exemplars of two novel, distinct object kinds (plastic novel artifacts-O1, agent-like puppets-O2). During a learning phase (16 trials), E1 showed competence in making O1s light up, but incompetence in activating O2s. Then, E2 showed competence in triggering a sound in O2s, but incompetence in activating O1s. At test, one of the Experimenters was present and the infant was given either a novel exemplar of the object-kind that the Experimenter knows (Experimenter Competent) or does not know about (Experimenter Incompetent). Importantly, infants could not activate the object by themselves. We measured whether infants display more help/information requests (as indexed through their looking proportion and number of looks) towards the Experimenter in the Experimenter Competent compared to the Experimenter Incompetent condition. The study was preregistered (https://aspredicted.org/ZVR_TV6). Results (N = 60) indicate that infants show a similar proportion of looking at the Experimenter in the Experimenter Competent (M = 0.10, s.d. = 0.10) and in the Experimenter Incompetent Condition (M = 0.12 , s.d. = 0.09), U = 402, p = .478, as well as a similar number of social looks (Experimenter Competent: M = 1.78, s.d. = 1.51; Experimenter Incompetent: M = 1.75, s.d. = 0.97), U= 400, p = .45. These results suggest that infants' attributions might not incorporate information about the domain of others' competence/knowledge and are rather non-specific. Infants may encode both experimenters as similarly competent without further specification, or mapping difficulties may arise by having to correctly map both experimenters' competence and incompetence.
To examine whether infants' performance is due to high task demands, in a simplified version we are exploring whether infants' social referencing at test is modulated by whether a single experimenter has previously demonstrated competence or incompetence in the relevant domain (N=4, target N=24). Data collection will be completed by the time of the conference. Together, these experiments will enrich our understanding of the flexibility of early information-seeking behaviors and will provide important insights regarding the representations underlying early selective learning, in particular how fine-grained and sophisticated these are early on.

P2-F-353 - Infants' perception of partially visible objects: Pilot studies

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Details

Infants' perception of partially visible objects: Pilot studies

Authors: Olivia Lowman[1], Victoria Fracalossi[1], Kira Ashton[1], Benazir Neree[1], Laurie Bayet[1]

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Infants as young as 2 months of age can recognize partially hidden objects as a whole unified object (Johnson & Aslin, 1995), provided that the motion of the object behind the occluder dynamically reveals key features of that object. However, the brain mechanisms that support this perceptual process of object unity in infants is not fully understood. In adults, the presence of feedback/recurrent connections in the processing of partially occluded objects is a key component of the neural mechanism enabling object unity (Tang et al., 2015). As a first step in determining the neural basis of how infants process partially occluded objects we seek to create a set of stimuli whose visual features are obscured by visual noise but nevertheless are sufficient to support object perception. Specifically, we aim to identify the visibility level by which infants are at threshold to detect the identity of obscured objects. This will allow us to develop stimuli at or slightly above that threshold for future studies probing the underlying neural mechanisms. Partially occluded images of common objects are paired with pure phasic noise patches (Figure 1A) generated using Gaussian bubbles (e.g., Gosselin & Schyns, 2001). The 16 different images presented are commonplace items infants can easily recognize, such as a bottle, banana, or dog. Visibility levels of 10%, 20%, 25%, 30%, 40%, 50%, 60%, and 100% were generated for each image-noise pair, to estimate psychometric curves. In ongoing pre-registered (Through AsPredicted) pilot and follow up studies, infants aged 12-15 months are participating in behavioral looking-times tasks using the platform Children Helping Science (formerly known as Lookit). During the initial study, infants are shown the image-noise pairs (Figure 1B), and differential looking times are measured and coded from recorded video using the programs Datavyu and ICatcher+. Because infants tend to look longer at objects than pure noise, differential looking times towards the partially obscured images will identify the threshold visibility level by which infants can distinguish a partial object from noise. Using the threshold visibility level determined from the initial study, infants in a future study will then be presented with image-noise pairs at or near threshold. The image-noise pairs will include either a congruent voice cue such as "Look! A cat!" or matched backwards speech (a reversal of the congruent audio). Differential looking times will again be measured. We hypothesize that infants will be more likely to look towards the partial object than phasic noise when presented with the congruent voice cue than when presented with matched backwards speech. A one-sided *t*-test will be used to determine if there is a significantly higher looking preference for the partial object when the image pairs include the congruent voice cue rather than backwards speech.

P2-F-354 - The origins of the mental timeline

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Details

Between infancy and middle childhood, the ability to form and retrieve episodic memories changes dramatically. However, the components of episodic memory develop asymmetrically: children are slower to develop the ability to remember "when" things happened relative to the abilities to remember "what" and "where". Even in adulthood, remembering the order of events is more difficult than remembering the locations of those events. This may be because time is an abstract concept we cannot see or touch. One hypothesized way we get around this challenge is by using space to represent time, which allows us to ground our representations of an abstract domain into a more concrete one.

Adults ubiquitously represent time using a mental timeline, a spatial model of time based on a linear reference frame, and automatically utilize it when remembering or reasoning about temporal information. Notably, both children and adults remember temporal order more efficiently when spatial cues consistent with the mental timeline are present. However, we do not know to what extent this memory advantage may be a product of our biology versus a cultural invention that develops through experience with cultural artifacts such as reading direction and linguistic metaphors.

The present work investigates whether temporal memory in 6-month-old infants is also facilitated by the presence of spatial cues. Infants were habituated to a triplet of images presented sequentially from left-to-right or nonlinearly across the screen. At test, infants saw the same triplet of objects presented centrally in a sequential order that was congruent or incongruent with the habituated triplet. If infants benefit from the linear spatial cues, then they should learn the sequence more efficiently when presented from left-to-right relative to nonlinearly. This project is a collaboration between two labs located in different countries on different continents.

In Experiment 1 (N = 41, data collected in France), infants were tested with sequences consisting of puppet faces. Overall, there was a trend for infants to look longer at the incongruent sequences at test. However, the predicted interaction between habituation condition and test trial type was not significant. These results suggest that habituating to a left-to-right sequence was not beneficial for memory. In Experiment 2, we tested if using simpler stimuli would improve memory. Preliminary data collected in the U.S. (N = 22) suggests that there is no effect of either habituation condition or test trial type on looking at test. Because some deviations may be easier to detect than others (e.g., BAC or ACB), in Experiment 3 (N = 7, data collection is ongoing) we are exploring whether the order in which the incongruent test stimuli appear influences infants' ability to discriminate between the test trials. These preliminary results suggest that infants' memory for temporal order may not benefit from a left-to-right spatial presentation. Linear representations of time may therefore be a product of cultural experiences and emerge only later in development.

P2-F-355 - Does culture shape 12-month-olds' joint attention skill and object processing skill? An eye-tracking study in Japan and France

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Details

The ability to jointly attend to objects with another person serves as a crucial social cognitive basis that leads to essential learning opportunities for infants. An important factor underlying such development is the social cues infants are exposed to. Infants growing up in various cultures may have different experiences with how caregivers interact with them. More crucially, a division seems to emerge between the Asian and Western cultures in caregiver-infant dyad interactions (Fernald & Morikawa, 1993; Zhang et al., 2021). Would such cultural variations influence how infants perceive social cues? The current study investigated whether infants' joint attention skill and their learning of the target referent via various social cues would be shaped by their respective culture.

Eye movements of Japanese- (n = 45) and French-learning (n = 39) 12-month-old infants were recorded using automatic eye-tracking. To examine their joint attention ability, each infant saw 6 *gaze-only* trials and 6 *pointing* or *referencing* trials across two blocks. A *gaze-only* trial showed a female actor turning her head to gaze at the target toy located on her right or left. A *pointing* trial showed the same actor pointing at the target toy in addition to head-turning. A *referencing* trial showed the actor saying a short infant-directed speech in the respective language along with head-turning (e.g., "Oh! Look!"). Following those 6 joint attention trials, we assessed whether infants had encoded the target toy of interaction with 4 object preference test trials where both the target and distractor toys were shown on the screen's right and left side.

Fixation data during both the joint attention trials and test trials were analyzed using mixed-effects regression models to examine the effect of culture and social cues. Overall, regardless of the social cue differences encountered in the joint attention trials, both Japanese-learning and French-learning 12-month-olds performed significantly above chance level and reliably followed the actor and attended to the target toy, such that they were more likely to look first and fixate longer at the target toy over the distractor toy across all three conditions (Figure 1 Panels A and B). Yet, some cultural differences seemed to emerge in infants' object learning during the first test trial immediately following the joint attention trials. While the Japanese-learning infants showed an enhanced novelty preference for the distractor over the target toy when *gaze-only* and *referencing* joint attention cues were provided, the French-learning infants did not show novelty preference for any of the three joint attention conditions (Figure 1 Panel C).

Together these findings reveal that, while infants robustly show competence in following different social cues independent of cultural variations, the way they attribute meaning to the interaction and learn the target referent may differ across cultures. The current study serves as a first step to a larger ongoing project which looks at the effect of cultural variations on infants' joint attention and social learning skills. More data from other cultures are being collected, and should provide further insights into whether cultures shape infants' social learning skills.

P2-G-356 - Fathers' involvement in early shared book reading on infants' later language development at 24-months

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Details

Frequent shared book reading and early book exposure in the home promotes young children's language and literacy development (see Fletcher & Reese, 2005 for review). Though research with fathers is scarce, previous studies have demonstrated that fathers actively participate in shared book reading activities with their children, though less frequently and perhaps differently compared to mothers (Cutler & Palkovitz, 2020; Duursma et al., 2008). Notably, frequent fathers' involvement in shared book reading has been demonstrated to have a positive impact on young children's vocabulary, cognitive, language and socio-emotional development (Baker, 2013; see Cutler & Palkovitz, 2020 for review). However, most of these father-child shared book reading research focuses on older children aged two years and above (e.g., Baker, 2014; Quach et al., 2017). Therefore, the aim of the present study was to examine the relationship between fathers' early shared book reading practices during the first year of life and infants' language and cognitive development at 24-months.

As part of a larger longitudinal study, the present study utilised available shared book reading frequency data as reported by mothers on nineteen fathers and their 24-month-old infants' developmental outcomes (53% females, n = 10). Frequency and duration of shared book reading, as well as number of books in the home reported at two time points were used in the present study (T_1: within the first year; T_2: at 24-months). Outcomes measured at T_2 were maternal reports of infants' communication and problem-solving skills, as well as infants' vocabulary development. These outcomes were measured by Ages and Stages (ASQ; Squires & Bricker, 2009), as well as MacArthur-Bates Communicative Developmental Inventories Vocabulary Checklist Form (MB-CDI; Fenson et al., 2007) respectively.

A significant and consistent pattern was found between maternal reports of fathers' shared book reading frequency within the first year (T_1) and the reported reading frequency approximately one year later (i.e., T_2 at 24-months), $F(1, 17) = 9.33$, $p = .007$, $R^2 = .35$, adjusted $R^2 = .32$. Frequent exposure to fathers' shared book reading activities within the early years also significantly contributed to infants' vocabulary development at 24-months. A moderate effect was found at both T_1, $F(1, 17) = 4.50$, $p = .049$ $R^2 = .21$, adjusted $R^2 = .16$, and at T_2, $F(1, 17) = 4.90$, $p = .041$, $R^2 = .22$, adjusted $R^2 = .18$.

Infants had a higher productive vocabulary at age 24 months when their fathers frequently read with them beginning in the first year of life as well as at 24 months. Encouraging fathers to engage in early shared book reading activities with infants' from as young as 6 months old can have a positive impact on infants' early vocabulary development. Future studies that focus on examining these positive associations on a larger and more comprehensive dataset directly obtained from fathers are warranted. Additionally, future research could further explore the potential impacts of the specific book reading behaviours that fathers engage in on infants' early cognitive development.

P2-G-357 - Threshold of rule productivity in infants and adults

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Details

Many cognitive rules have exceptions. Recent studies showed that 12-14-month-olds can learn abstract rules from input containing a small number of exceptions, but fail when there were too many exceptions (Gomez & Lakusta, 2004; Koulaguina & Shi, 2019). We recently conducted experiments (aaaa & bbbb, 2023) to determine the potential threshold of rule generalization, by constructing artificial rules using a natural language (Russian) unknown to our 14-month-old participants. We manipulated rule exemplars and exceptions according to the productivity threshold of the Tolerance Principle (TP) (Yang, 2016), the only threshold explicitly proposed in the field. Specifically, in one of our experiments, 11 of the 16 total training exemplars represented the rule, and the 5 exceptions fell just below the TP-threshold, thus predicting rule generalization (see Table 1). In another experiment, 10 training exemplars represented the rule, and 6 exceptions were just above the TP-threshold, thus predicting no rule learning. The training was implicit, allowing infants playing while hearing the stimuli. After training, infants were tested in a preferential looking/listening procedure, with new exemplars confirming to the trained rule versus to an untrained rule. As predicted, results showed successful rule generalization in the 11+5 experiment, but not in the 10+6 experiment. Furthermore, rule learning was categorical: training with different levels of exceptions below the threshold yielded equal success, while varying numbers of exceptions above the threshold yielded uniform failure.

Our next question was whether the TP-threshold for rule generalization is unique to infants. In previous rule-learning studies (e.g., Hudson Kam & Newport, 2005 & 2009, Austin et al, 2021, Schuler et al, 2016), which were not designed to test any productivity threshold, adults and children showed different learning processes. We therefore conducted adult experiments using the same Russian sentences as in our infant experiments, with the same manipulations of the training input. Similar to infants, adults were trained with the auditory stimuli while playing a video game. They were then tested with new exemplars conforming to the trained rule versus to a untrained rule and had to rate each on a 4-point scale. Our predictions centered on potential similarities or differences in adults' responses between the two experiments. That is, if adults were sensitive to the TP-threshold like infants, their responses to trained versus untrained rules should differ in Experiment 1 (11+5), but not in Experiment 2 (10+6). However, if adults are insensitive to the TP-threshold, their performance should be similar in the two experiments, given the small variation in the number of rule exemplars versus exceptions.

Our results show that like infants, our adults' responses to the trained versus non-trained rules were significantly different in Experiment 1, $t(11)=-3.171$, $p=.009$, but not in Experiment 2, $t(10)=1.122$, $p=.29$, as predicted by the TP.

Overall, our results demonstrate that rule generalization operates according to the TP in both infants and adults. Interestingly, both age groups showed sensitiv to the TP-threshold for rule productivity, even in an implicit task, suggesting that the learning system can implicitly track the precise numbers of rule exemplars and exceptions.

P2-G-358 - A meta-analytic approach to unveiling children's scale errors

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Details

Scale errors are intriguing developmental phenomena characterized by attempts to execute object-specific actions on diminutive objects (e.g., a child endeavors to get into a miniature car). Scale errors are typically observed during toddlerhood, peaking at approximately 18–24 months, and become much less prevalent before and after this period. Despite the various proposed viewpoints on the developmental mechanisms of scale errors, a unified account of how different factors interact and affect scale errors is lacking. Moreover, previous statistical approaches have been inadequate given the specificity of the data structure. The distribution of the scale error observations is skewed considerably toward zero, violating the normality assumption. Traditional studies have also arbitrarily discretized developmental indices, such as children's age in months, potentially distorting the characteristics of scale errors.

In this study, we conducted a secondary analysis of aggregated datasets from diverse studies (n = 528; 439 from laboratory data and 89 from classroom data). Using a more appropriate statistical approach, we investigated how developmental changes in scale errors can be described. We implemented a Zero-Inflated Poisson (ZIP) regression, which can handle count data with a stack of zero observations, and treated developmental indices as continuous variables. This approach enabled us to simultaneously and discernibly examine whether developmental linearity or nonlinearity concerns the presence or absence of scale errors (i.e., the logistic part) or the number of scale errors observed (i.e., the count part).

The results suggest that the developmental trend of scale errors followed an inverted U-shaped curve rather than a simple linear function. Nonlinearity in scale errors belonged to different aspects between the laboratory and classroom data. Lab-based scale errors exhibited an inverted U-shaped curve with a peak at 18 months for the logistic part, whereas the count part was less influenced by age. Conversely, the logistic part of the classroom dataset was less related to age, whereas the count part followed a quadratic function, peaking at 26 months. These distinctions imply that scale errors between laboratory and classroom settings reflect different task-specific conditions and/or different aspects of children’s cognitive abilities. Additionally, repeated exposure to scale error tasks reduced the number of scale errors, and girls made more scale errors than boys.

Furthermore, a model comparison revealed that among different types of vocabulary size as developmental indices, predicate vocabulary size (i.e., adjectives or verbs) predicted developmental changes in scale errors better than noun vocabulary size. Although scale errors have been discussed in relation to noun lexical development, this finding emphasizes the importance of considering adjective and verb lexical development, which demands more sophisticated abstraction abilities.

This meta-analytic study provides detailed and comprehensive insights that deepen our understanding of the developmental trends in scale errors. Our findings lay the foundation for future research exploring the connections between scale errors and other cognitive abilities, with the aim of providing a unified account of the underlying mechanisms. The application of the ZIP model enhances the researchers' ability to decipher the factors influencing scale error production, demystifying the mechanisms behind these phenomena.

P2-G-359 - Convergence and divergence of play activities in infants and young children developing with and without delays from 8 to 60 months

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Details

OBJECTIVE

Play contributes to infants' and young children's development of knowledge and their ability to think, impacting language and social development. Further, children developing with delays often manifest delays in play. They do not benefit from play as typically developing children do, necessitating interventions. Although much is known, comparisons across play studies are difficult: descriptions, purposes and methods differ. We therefore set out to gather new play observations of infants and young children who are developing with and without delays.

This presentation centers on ***convergence*** of comparisons between children developing with delays (DD) and those developing typically (TD). Contributions to ***diversity*** focus on inclusion of children with various delays, and a participant sample from diverse ethnic backgrounds.

METHOD

In a cross-sectional design, 30-minute naturally occurring play observations, across 4 groups of toys, were gathered from 492 infants and young children (289 TD; 203 DD) playing with a familiar caregiver in their homes and videotaped at 8-, 12-, 18-, 24-, 30-, 36-, 42-, 48-, 54-, and 60-months. Backgound information for both groups was similar: approximately 64% identified as white; 13% as Multiracial; 10% as Asian; 8% as Black; and 5% as Latino. The TD sample was 49% boys and the DD sample was 64% boys. The nature of delays for the DD children is presented in Table 1. Observations were completed within a two-week window of birthdays or half birthdays.

Through exhaustive analyses, we expanded Lifter's (2000) review of 15 qualitatively different play categories to 27, based on our definition of object play (child performs an action with a toy). Coders achieved at least 85% agreement, recording activities into categories. Analyses focused on frequency (activities/category), variety (number of different exemplars/category), and factor analyses.

RESULTS

The same play categories were identified in both groups. Both groups demonstrated high frequencies of activities. The mean variety of play activities differed, however, across categories and age groups. The DD children expressed fewer exemplars of play activities within categories (Figure 1).

Factor analyses of the 27 categories for both groups revealed five clusters that emerged sequentially – Perceptually-based; Representationally-based; Pretense; Role-Play; and Construction – accounting for 52% of the variance, resulting in 21 categories. Progress for DD and TD was generally similar in the perceptually-based (e.g., putting a puzzle back together) and representational (e.g., stirring a spoon in a

cup) categories. Progress in the pretense (e.g., using an imaginary key to open the car) and role-play/construction categories (e.g., building a house) was slower and more difficult for DD overall.

CONCLUSIONS

Variety within play categories as an assessment of knowledge, in addition to the differentiation of play categories within the factors, provided a window on aspects of play that were especially difficult for DD children to learn. Not only were these children developing at a slower rate, they were not consolidating their knowledge in as great a depth as the TD children. Implications for assessment and intervention center on evaluating a child's development in play to identify and enhance variety within those categories emerging in a child's play rather than simply teaching new play skills.

P2-G-360 - Latent Profile Analysis as a data-driven approach to characterize infant baseline electroencephalography (EEG).

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Details

Electroencephalography (EEG) is a powerful tool for probing neurodevelopment. Decomposing the oscillatory EEG signal into component frequency bands can reveal properties of cortical maturation and functional organization from the earliest stages of life. However, determining experiential contributors of individual variation in the EEG power spectrum is made challenging by statistical power requirements necessary to test associations between multiple (often interacting) environmental variables and power in multiple frequency bands (e.g., delta, theta, alpha, beta, gamma). Moreover, considering patterns across frequency bands – as opposed to exploring individual bands in isolation – might reveal important new insights into neurodevelopmental processes. We demonstrate how a data-driven statistical approach – latent profile analysis (LPA) – can be used to isolate unique neurodevelopmental profiles from infant EEG. This technique provides a powerful data reduction strategy and facilitates identification of variables that modify early neurodevelopment.

We will begin by briefly introducing EEG as a method for exploring early neurodevelopment and will then provide an overview of the LPA approach. Using both cross-sectional and longitudinal data collected from infants at high risk for exposure to early life stress, we demonstrate how this approach can isolate subgroups of infants with relative risk or resilience for long term consequences of early adverse experience. We also suggest how profile membership could be used to predict developmental outcomes.

Data were collected from mother-infant dyads (n = 116) enrolled as part of a longitudinal project designed to explore effects of early adversity on development. Family demographic variables and exposure to stress were assessed using maternal-report questionnaires. Five minutes of baseline EEG was collected from infants at 2, 6, 9, 12, 24, and 36 months of age. Data were processed using the Harvard Automated Processing Pipeline for Electroencephalography (HAPPE; Gabard Durnam et al., 2018), and power in six frequency bands (delta, theta, low alpha, high alpha, beta, gamma) was

extracted using the Batch Electroencephalography Automated Processing Platform (BEAPP; Levin et al., 2018). Latent profile analysis was used to fit latent class models to whole-brain EEG power in each frequency band (both log10-transformed absolute and relative power). Each analysis began with a 2-class model, with successive models adding more classes until model fit no longer increased. At 2-months, we found two unique profiles derived from absolute EEG (one profile displaying high, the other displaying low power across all frequency bands), and two unique profiles derived from relative EEG (one profile displaying low power in high frequency bands and high power in low frequency bands; the other displaying the reverse pattern; Pierce et al., 2019). Multinomial logistic regression determined that maternal perceived stress and maternal education, adjusting for other socioeconomic variables, predicted membership in unique EEG profiles. Comparable profiles were identified at later time points, suggesting stability of unique EEG profiles over time. Applications to both cross-sectional and longitudinal analyses will be discussed.

We demonstrate how this novel use of LPA can be used to isolate unique infant EEG profiles that are a) associated with variation in infants' early experience, and b) indicative of relative risk/resilience for subsequent development.

P2-G-361 - The ability to discriminate small and large number of syllables at 9- to 10-months of age

Natalia Reoyo Serrano [1], **Chiara Nascimben** [2], **Silvia Benavides-Varela** [1]

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Details

Studies in the visual modality indicate that infants possess two cognitive systems for encoding numerical information: the approximate number system that represents large numbers (>4) and a parallel individuation system that tracks and represents small (<3) number of objects (Feigenson, Dehaene & Spelke, 2004; Hyde, 2011). The available studies in the auditory modality, on the other hand, yielded mixed evidence. While infants appear to rely on the approximate number representations when listening to tones (vanMarle & Wynn, 2009), they seem to establish precise auditory representations when listening to syllables (Bijeljac-Babic et al., 1993; Benavides-Varela & Reoyo-Serrano, 2021). To date, however, no study has directly assessed whether an incompatibility in representational systems for small and large sets -similar to that described for visual objects- can be verified with syllable sets. To address this question the present study investigated 9- to 10-month-olds' (N = 25) numerical discrimination abilities in an online auditory working memory test using a within-subjects design. Infants were tested in their ability to distinguish between 2 and 3 sets of syllables (Exp 1) and between 2 and 4 sets of syllables (Exp 2).
The experiment consisted of a series of familiarization and a test trials (Fig 1). The familiarization began with the display of a central visual attractor and two white squares, one on the left and one on the right side of the screen. When the infant fixed the central attractor, a syllable was repeated (either two or three times for Exp 1; either two or four times for Exp 2). After the offset of the stimulus, the central attractor disappeared, leaving only the two white squares visible for 1 s. Subsequently, a looming puppet appeared in one of the two white squares for 2 s. The side of the presentation of the puppet was contingent on the sequence: for example, the 2-syllables sequence could predict the puppet's appearance in the left square, while the 3-syllables sequence predicted the puppet' s appearance in the

right square. The test phase was similar to the familiarization phase, except that after each sequence no puppet was displayed. Crucially, continuous variables, such as individual item duration, inter-stimulus duration, pitch, intensity, and total duration, were controlled for across trials.
In experiment 1 infants successfully discriminated 2- and 3-syllable sequences. Their performance was better for the smaller-number sequence (2-syllables sequence) than for the 3-syllable sequences [t(24) = 2.39; p = .02; Cohen's d = 0.48]. Infants also discriminated 2 and 4-syllable sequences in experiment 2, however, their response patterns reversed. Participants showed better performance for the larger number sequence than the smaller number sequence [t(24) = -2.54; p = .01; Cohen's d = -0.51]. These findings indicate that infants can flexibly access the representational systems that yield numerical representations both in the small and the large number range and that this flexibility might be facilitated by sounds that are ecologically relevant to the infant, namely those of linguistic nature.

P2-G-362 - Pre- and postnatal factors associated with cognitive development in the first 1000 days: Insights from a longitudinal cohort in rural Gambia

Samantha Mccann [1], **Bosiljka Milosavljevic** [2], **Ebrima Mbye** [3], **Ebou Touray** [3], **Tijan Fadera** [3], **Sarah Lloyd-Fox** [4], **Clare Elwell** [5], **Sophie Moore** [1]

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Details

Background

It is widely recognised that the first 1000 days of life (conception to 24 months of age) are an important period for the developing brain, both in terms of rapid growth and heightened plasticity. Therefore, the brain is particularly vulnerable to adversity including undernutrition, infection and emotional or physical stress during this time, with lasting effects on educational achievement, wealth, and mental health. However, research shows that interventions to support the developing brain within the first 1000 days can have long lasting positive impact. The contribution and timing of individual risk factors is helpful in the design of targeted interventions. This study makes use of a longitudinal dataset from the Brain Imaging for Global Health (BRIGHT) Project (Lloyd-Fox et al, 2023), which measures cognitive development repeatedly from 0-24 months, as well as a diverse range of potential risk and protective factors. The aim of this study is to investigate the contribution of risk and protective factors to cognitive development in early infancy (5 months of age), as well as to progression in cognitive development from 5-24 months of age.

Methods

Infant cognitive development was measured using the Mullen Scales of Early Learning at 5, 8, 12, 18 and 24 months of age, from which standardised early learning composite scores (ELC) were derived. Data were also collected on a range of factors including family socioeconomic status, parental education,

maternal nutritional status during pregnancy, maternal age and parity, caregiving practices, infant diet, birthweight (converted to a weight-for age z score (WAZ)) and infant iron status.

Analyses

As well as assessing the relationship between potential risk and protective factors and ELC scores at 5 months, we calculated a conditional relative ELC score from 5-24 months, using a statistical technique commonly used for infant physical growth trajectories (Lessa Horta et al, 2017). This metric indicated deviance from expected progression in cognitive development from 5-24 months, allowing us to identify factors associated with greater or less than expected progression in ELC scores. In other words, this method enabled the detection of factors which may be suitable targets for intervention after 6 months of age.

Results

ELC score at 5 months was predictive of ELC score at 12, 18 and 24 months of age (12mo co-efficient= 0.34, p<0.001; 18mo co-efficient= 0.38, p=0.003; 24mo co-efficient=0.45, p=0.010). Birth WAZ (co-efficient=2.95, p=0.059) and paternal education (co-efficient=1.54, p=0.029), as well as iron status at 5 months of age (co-efficient=0.60 p=0.007), were positively associated with ELC score at 5 months of age. When adjusting the ELC at 5months, birth WAZ was additionally positively associated with conditional relative ELC score from 5-24months of age (co-efficient=2.93 p=0.047), as were infant iron status at 1 month of age (co-efficient=0.032, p=0.011) and maternal age (co-efficient=0.322, p=0.038).

Conclusion

These findings indicate the importance of prenatal growth and early postnatal nutritional status on cognitive development, suggesting that nutrition sensitive intervention under 6 months of age maybe key to supporting cognitive development in the longer term. Targets for intervention after 6 months of age were less clear and require further investigation.

P2-G-363 - Estimating the duration of a moment, from early infancy to adulthood

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Details

While our experience of the world appears continuous, perception actually involves discrete sampling of the environment into successive moments. In the present work, moments are operationalized as temporal integration windows (TIW). When successive stimuli are presented closely in time, within a single TIW,

they are integrated into a single coherent percept; but if the stimuli are separated by longer delays, occurring in two successive TIWs, they give rise to two distinct percepts (Arnett & Di Lollo, 1979; Wutz et al., 2016).

In two experiments, we aimed at estimating the TIW across development from early infancy to adulthood. We designed a visual search task where participants saw sequences of 2 alternating displays separated by variable stimulus onset asynchrony (SOA = 16 to 116 ms in Experiment 1; SOA = 100 to 400 ms in Experiment 2). In integration trials (Fig. 1A), only half-faces were presented in each display, but a complete face could be seen and attract attention if the two displays were integrated into one unique percept. In contrast, in segmentation trials (Fig. 1B), the integration of the two displays lead to the perception of multiple complete faces, whereas only one complete face was actually drawn on the screen. This target face should attract attention if the two displays were perceived as two distinct percepts. For SOAs shorter than the TIW, the complete face (the target) should be better detected and attract more attention in integration than in segmentation trials; the opposite pattern is expected for SOAs longer than the TIW. Eye-tracking served to measure participants' detection of the target, signaled by longer looking time towards the target than towards the opposite distractor.

In Experiment 1, repeated-measures ANOVAs with Trial Type (integration, segmentation) and SOA (16, 32, 83, 116 ms) were performed to estimate adults', children's and infants' TIW. Interactions between Trial Types and SOA in adults, in 5-year-olds and in 3-year-olds suggested TIWs of about 58 ± 25 ms in both adults (N = 24) and 5-year-olds (N = 24), and a longer TIW of about 100 ± 16 ms in 3-year-olds (N=24) (Fig. 2A). No effect of SOA but a main effect of Trial Type was observed for 5-, 8- and 18-month-olds (N=24 per group), suggesting a TIW longer than 116 ms in infancy (Fig. 2B). In Experiment 2, with SOAs of 100, 150, 250 or 400 ms, 5- to 8-month-olds performance on segmentation trials was at chance for all SOAs, whereas there was an effect of SOA on the target detection in integration trials. Infants detected the target for SOAs = 100, 150 and 250 ms, but not for SOA = 400 ms, suggesting a TIW duration of about 325 ± 75 ms (Fig. 2C).

Overall, our findings document and quantify the acceleration of perceptual sampling in the course of development. Perception appears about six times slower at 5 months than in adulthood, and reaches adult-like speed around 5 years of age.

P2-G-364 - Maternal wellbeing and responsiveness complement benefits of thiamine supplementation for Cambodian infants' neuro-cognitive development

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Details

Thiamine deficiency is endemic in regions where thiamine-poor white rice is a staple food, such as Cambodia. Suboptimal maternal thiamine intake results in low milk-thiamine concentrations, placing

exclusively breastfed infants at risk of thiamine deficiency, which can be fatal and may also undercut surviving infants' neuro-cognitive development.

In a first test of this hypothesis, we conducted a randomized controlled trial (RCT) investigating the extent to which thiamine supplementation for lactating mothers protects infant neuro-cognitive development. We found that maternal thiamine supplementation produced significant dose-response improvements in infants' Early Learning Composite scores on the Mullen Scales of Early Learning (MSEL), especially in the language domain (Measelle, et al., 2021).

A key remaining question, however, is the extent to which benefits of thiamine supplementation hold under varying conditions of maternal well-being and responsiveness – factors known to influence children's neuro-cognitive development across many cultural/resource contexts (Bornstein, et al, 2008; Urrizar & Muñoz, 2022). As part of the larger RCT, we queried mothers regarding their mental/emotional well-being and assayed their responsiveness to infants in a joint-attention task. We then examined the extent to which these factors moderated benefits of thiamine supplementation for infants' neuro-cognitive development.

Method

335 mothers in rural Cambodia received a daily capsule (2-24 weeks post-partum) containing either 0, 1.2, 2.4, or 10 mg thiamine hydrochloride. Infants' neuro-cognitive development was assessed via the MSEL at 2, 12, and 24 weeks. At each timepoint, mothers answered World-Health-Organization-validated questions about anhedonia ("How often have you been bothered by having little interest or pleasure doing things?) and depression ("§How often have you been bothered by feeling down, depressed, or hopeless?"). In a joint-attention task at 12 and 24 weeks, mothers attempted to facilitate infants' interest in a novel object. Maternal responsiveness composite scores were computed from subsequent video coding of mothers' a) orienting the object for infants' viewing, b) supporting joint engagement, c) contingent responding, and d) affective attunement.

Results

A series of multi-linear regression models probed the extent to which maternal variables were associated with infants' 24-week MSEL scores. The base model included variables for a) thiamine supplementation dose, b) baseline MSEL scores controlling for infants' 2-week neuro-cognitive status, and maternal c) anhedonia, d) depression, and e) responsiveness. These models revealed significant associations between all independent variables except anhedonia with 24-week MSEL ELC scores (and especially strong associations for receptive language scores, see Table 1). A second set of regressions added interactions between maternal variables and thiamine supplementation dose to the models: interaction terms were all non-significant associates of 24-week MSEL scores. The latter findings disconfirmed a moderation account.

Together, our results indicated that reductions in maternal depression and increases in maternal responsiveness independently complement benefits that thiamine supplementation hold for neuro-cognitive development in infants at-risk of thiamine deficiency. These findings showcase the importance of supporting maternal well-being and skills for responsiveness in addition to supporting thiamine status for protecting infants' neuro-cognitive development, key issues that inform the design of population-level interventions to ensure infants' health and developmental well-being.

P2-G-365 - Caregiving quality and children's cognitive development: A new look at an old question

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Details

For more than 70 years, psychologists have measured associations between attributes of caregivers—including their education, attitudes, beliefs, and behaviors—and attributes of their young children. This research has revealed that such associations can have diverse causes. For example, children of more educated parents have been found to do better in school, but a recent randomized controlled experiment in Ghana showed that subsidies to adolescents that increased their education produced better cognitive outcomes if the subsidized student was female but not male, and that the effects of education on children's outcomes occurred at 5 and 7 years but not at younger ages (Duflo, Dupas, & Kremer, 2021; Duflo et al., 2023).

With the aim of generating further hypotheses of environmental effects of caregivers on their children, we analyzed the data from over 1256 children and their primary caregivers who were tested in Ghana. During visits to their homes, local surveyors assessed caregiver characteristics and behaviors across eight categories: education, occupational status, socio-economic status, preventive health behaviors (e.g., presence of bed nets, soap and clean water in the home), stimulation of the child (e.g., reading, singing, playing with toys), depression index, beliefs about children's development (e.g., "When should you start speaking to a child?"), and investment in the child's education (e.g., books in the house, attendance at teacher meetings). During the same visits, surveyors tested all children in the caregiver's care who fell within four age ranges centered on 1.5, 3.5, 5.5, and 7.5 years, to assess their cognitive skills. At all four ages, children's language, numeracy, and executive function were tested; at the older three ages, children's spatial cognition and social cognition were tested as well. Here we measure associations between the caregiver and child test performance.

First, are there associations between caregiver attributes and child outcomes in our different age groups? On the composite scores of children at the four ages, we find that associations between child cognitive outcomes and caregiver education and SES are almost absent at 1 year and increase with age from 3 to 7 years. Associations between the caregiver's investment in the child's education and the child's cognitive outcomes are present only at the two oldest ages. In contrast, caregiver stimulation is associated with child outcomes at all the ages (Table 1). Second, are these associations stronger for cognitive skills that develop naturally, like executive function and social cognition, or for skills that are taught in school, like reading and mathematics? Here, the findings do not support this divide. Associations are stronger between caregiver quality and child outcomes in language and numeracy than in social cognition and executive function (Table 2).

In summary, caregiver qualities are associated with children's cognitive outcomes in multiple ways. These findings suggest promising directions for future evaluations of interventions on parents with the goal of enhancing their children's cognitive growth. The findings also suggest that longstanding research questions, pursued in the past through research focused on caregivers and children in wealthy countries, can be pursued as well in developing countries.

P2-G-367 - From infancy to school-age: how are caregiver speech and maternal educational attainment associated with cognitive development?

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Details

Background

Research has consistently shown that a rich home language environment is positively associated with later language skills in young children (Hart & Risley, 1995). Children who have greater language skills early on go on to perform better throughout their academic lives (Duncan et al., 1998). Socioeconomic status (SES), and by extension parental education, positively impact the quantity and quality of the language used in homes (Bradley & Corwyn, 2002; Hoff et al., 2002). Despite the volume of research looking into how parental (particularly maternal) educational attainment and caregiver speech input influence cognition, there is less known about how the associations pan out longitudinally through school age.

Methods

The current sample (N=49) included infants from a longitudinal study of infants at low and high familial risk for autism. Participants were included if they completed at least one home-language recording at 15 months, and participated in behavioral assessments at 24 months and school age. The home language environment was characterized by automated variables generated using the LENA Pro software suite (Xu, Yapanel, & Gray, 2009). Adult Word Count (AWC) and Conversational Turn Count (CTC) were analyzed. AWC measures the number of adult words spoken in close proximity to the target infant and CTC measures reciprocal exchanges between an adult and the target infant that occur within 5 seconds of one another. The Verbal Development Quotient from the Mullen Scales of Early Learning (MSEL) and Verbal and Non-Verbal subscale scores from the Differential Abilities Scales (DAS) were used to assess cognitive abilities at 24 months and school age, respectively. General linear models with caregiver speech and maternal education as the predictors were set up; autism diagnosis was a covariate. Further, three mediation models (see Fig. 1) explored how different variables contributed to the linear associations of maternal education and caregiver speech with school-age cognitive outcomes.

Preliminary Results

General linear regression showed a significant positive association between caregiver speech variables at 15 month and performance on the DAS at school age (Table 1). Two of the three mediation models showed significant mediation effects (Figure 1). There were no significant group differences between the children who received a diagnosis of autism and those who did not. These results will be followed up using advanced analyses (path analyses/moderated mediation).

Conclusion

The current study is one of the first to study the complex interplay of maternal education, home language environments during infancy, and school-age cognitive performance. Caregiver speech input and maternal education during infancy were positively associated with school-age cognitive assessments across children with or without ASD. Additionally, language skill at 24 months mediated the significant associations between caregiver speech/maternal education at infancy and school age cognitive outcomes. The results suggest that early language environments play a significant role in downstream development. The early home language environment is considered a modifiable factor. Therefore, understanding how early influences in a child's environment impact school-age abilities can help promote stronger cognitive outcomes.

P2-G-368 - Auditory sensitive period timing and language development in infants with prior GABA agonist drug exposure

Kelsie Lopez [1], **Ellen Underwood** [2], **Alice Tao** [3], **Isabelle Kim** [4], **Siobhan Coffman** [5], **Charles Nelson** [5], **Charles Berde** [5], **Laura Cornelissen** [5], **Takao Hensch** [5], **Laurel Gabard-Durnam** [1]

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Details

200,000 infants receive GABA agonist drugs (GA) annually in the United States (Rabbitts et al., 2010; Ing et al., 2012). Animal model research suggests that early GA exposure impacts development by accelerating sensitive periods in the brain (Takesian and Hensch, 2013). How GA exposure influences human sensitive periods remains an open question to inform fundamental developmental learning mechanisms. We address this question by focusing on the native-non-native language sensitive period in infancy. We tested whether early prolonged GA exposure accelerates this sensitive period's timing by evaluating electroencephalography (EEG) power at 3, 5, and 10 months in infants with (n = 37) and without (n = 45) early GA exposure. Participants in the GA group were exposed to GABA agonist drugs prior to 2.5 months for an average of 5.28 hours (range: 1.02 – 20.71 hours) and with an average of 1.32 exposures (range: 1 – 5 exposures). The average age of first GA exposure was 0.45 days corrected age (range: -1.18 – 2.26 days). EEG was collected during a native-non-native phoneme task using the English /da/ and Hindi /ɖa/ contrast. Theta and beta power were targeted because they are robustly associated with early language development, and in particular with processing phonemes and syllables (Vanvooren et al., 2015). Additionally, the maturational trajectory of the theta/beta ratio was evaluated. Further, GA effects on language development were assessed with the Ages and Stages Questionnaire (ASQ) communication subscale at 10 months. Mixed effects models revealed that cumulative GA predicts more theta and beta power at 3 months, less theta power at 5 months, and less theta and beta power at 10 months relative to the comparison group. Additionally, the theta/beta ratio decreased from 3 to 10 months as a function of cumulative GA exposure, indicating an early maturational shift toward higher frequencies relative to the control group. Further, this precociously lower theta/beta ratio at 3 months predicts lower ASQ communication scores at 10 months in the GA exposed group. These results inform how exposure to early GA can accelerate human sensitive period developmental timing and impact subsequent learning.

P2-G-369 - Investigating the effects of GABA agonist drug exposure on sensitive period timing and language development in infants

Melany Morales-Ghinaglia [1], **Kelsie Lopez** [2], **Siobhan Coffman** [3], **Isabelle Kim** [4], **Alice Tao** [5], **Ellen Underwood** [6], **Charles Nelson** [7], **Charles Berde** [3], **Laura Cornelissen** [3], **Takao Hensch** [8], **Laurel Gabard-Durnam** [2]

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Details

In the first year of life, infants undergo perceptual tuning during experience-expectant mechanisms known as sensitive periods. The onset of sensitive periods involves a coordinated symphony of biological mechanisms that operate jointly to establish a balanced excitatory-inhibitory (E-I) neural circuitry, with maturation of gamma-amino butyric acid (GABA) circuits assuming a pivotal role. Recent literature using animal models suggests that GABA agonist drugs accelerate sensitive period timing. While it is well-known that the developmental milestones achieved during these periods have cascading effects on subsequent behavioral and cognitive abilities, there is a paucity of research regarding the possible modulatory effects of precocious GABA agonist inhibition on sensitive period timing and language development in humans. The present study compares infants who underwent general anesthesia (GA) prior to 2 months with a control group unexposed to GA, examining the effects of precocious maturation on auditory sensitive period timing and language outcomes. To do so, we propose a novel method for assessing early brain maturation, utilizing resting-state and task-evoked electroencephalographic (EEG) data collected at 2-, 4-, and 10-months to derive a spontaneous/evoked (S-E) ratio that is representative of the E-I circuitry. Preliminary results indicate that the S-E ratio at 4 months is predictive of language skills at 10 months, with no across-group differences. This 4-month ratio occurs during the window of transition during the sensitive period for perceptual narrowing. Thus, while GA exposure has no significant effect on auditory sensitive period timing, the S-E ratio offers a promising avenue for mapping the trajectory of sensitive periods in developing populations.

P2-G-370 - The link between sign language (ASL) and cognition in hearing 6-month-old infants: A role for exposure

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Details

Even before infants begin to speak, listening to language exerts a powerful influence on their cognition. For infants as young as 4 months, listening to their native language supports their ability to form object categories, yet listening to other carefully-matched signals like sine-wave tones or

backwards speech offers no such advantage (Ferry, Hespos, & Waxman, 2010). Surprisingly, infants' earliest link between language and object categorization is broad enough to include auditory signals such as nonnative languages and vocalizations of non-human primates (Ferry, Hespos, & Waxman, 2013). Recent evidence reveals that this link to cognition is initially abstract enough to include language in the visual modality. At 4 months, hearing infants observing American Sign Language (ASL) successfully formed object categories, but by 6 months, ASL no longer exerts this advantage (Novack et al., 2021). This study opens fascinating questions about the initial breadth of infants' language-cognition link and the mechanisms by which it is tuned to their own native language and language modality.

There is considerable plasticity in the first year, as many deaf infants are not systematically exposed to a sign language before 6 months, yet they still acquire sign language. There is also strong evidence that even a few minutes of exposure to certain auditory signals permits infants to maintain (for lemur vocalizations) or establish (for sine-wave tone sequences) a link between that signal and cognition (Perszyk & Waxman, 2016; Ferguson & Waxman, 2016). What remains unknown is whether and how exposure to language presented in the visual modality supports and tunes that language-cognition link.

To address this, we ask whether briefly exposing 6-month-old hearing infants to ASL permits them to maintain the link between this signal and cognition. During the Exposure phase, infants viewed a 2-minute video of a woman signing a children's story in ASL. Next, infants participated in the now-standard categorization task: during Familiarization, infants viewed 8 images from one category (e.g., dinosaurs), each presented in conjunction with ASL. At Test, infants viewed a new image from the now-familiar category (e.g., another dinosaur) and a new image from a novel category (e.g., a fish), presented simultaneously. If brief exposure is sufficient, then 6-month-old infants should successfully form the object category, indicated by a looking preference to the novel Test image.

Results indicate that the exposure captured infants' attention but was not sufficient for ASL to permit 6-month-old infants (N=37, M_{age}=6.27 months) to link this signal to cognition. Performance at test did not differ significantly from chance ($M_{novelty\ preference}$= .48, t(36)= -.48, p= .60), despite infants' active engagement during Exposure and the categorization task. This indicates that infants require either more extensive exposure, or more interactive exposure. Experiments testing these hypotheses are currently underway.

This work has important implications for deaf infants, many of whom are not exposed systematically to sign language before 6 months. This research will illuminate infants' remarkable plasticity and the powerful shaping role of language experience on early cognitive development.

P2-G-371 - Effects at 12 months of a low-cost primary care intervention using finger puppets to support language promotion in early infancy

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Details

Objective: The early home language environment is critical for future vocabulary growth, school readiness, and academic success, yet few evidence-based primary care interventions exist to support early language promotion. We aimed to determine if introducing finger puppets in the primary care setting during infant well visits improves parenting and language outcomes at 12 months.

Methods: We used an experimentally staged introduction where the intervention was introduced at different time points to all participants. Eligible infants were born full-term weighing at least 2.5kg with no condition known to affect neurodevelopment. Caregivers were at least 18 years and fluent in English or Spanish. Intervention cohorts were enrolled at ages 2 months (early intervention) and 6 months (late intervention), given a puppet, and followed two weeks later by phone to assess dosage. High dosage was defined as using the puppet daily. At 12 months, a usual care cohort was enrolled and outcome measures were collected for all participants, including maternal depression (Patient Health Questionnaire, PHQ-9), the cognitive home environment (StimQ-Toddler), preverbal skills (Communication and Symbolic Behavior Scales Developmental Profile Infant-Toddler Checklist, CSBS-DP-IT), and vocabulary development (MacArthur-Bates Communicative Development Inventories infant short forms, CDI SF). Sociodemographic risk was assessed by calculating a cumulative risk index, scoring one point for each of the following factors collected at enrollment: [1] single, divorced, or separated marital status, [2] Hispanic or non-white maternal race/ethnicity, [3] maternal education less than high school/GED, [4] government-sponsored health insurance. Intention-to-treat analyses compared all intervention participants with usual care. Per protocol analyses examined only those known to use the intervention (high and low dosage) and usual care participants. Continuous variables were compared using Student's t-test (two groups) or one-way analysis of variance (ANOVA) using Proc Glm with Tukey HSD for post-hoc tests (three groups).

Results: Of 413 families screened, 248 (60%) were eligible, 180 (73%) enrolled, and 154 (86%) completed the 12-month visit. Most children (84%) were on government-sponsored insurance. (Table 1) There were no differences between early and late intervention outcomes, so these cohorts were combined. In intention-to-treat analysis, the intervention cohorts scored better than usual care on aspects of the cognitive home environment, including the Availability of Learning Materials (ALM) (5.50 vs. 5.02, p=0.04) and Parental Involvement in Developmental Advance (PIDA) (8.30 vs. 7.58, p=0.02) StimQ-T subscales, and receptive vocabulary (CDI SF English) (61.0 vs. 50.1, p=0.05). In per protocol analysis, high dosage scored better than low dosage and usual care on the StimQ-T ALM (5.83, 5.08, 5.02, p=0.01), preverbal communication (CSBS-DP-IT) (72.3, 57.2, 59.2, p=0.01), and receptive vocabulary (CDI SF English) (73.4, 56.1, 50.1, p=0.0002). (Table 2) Linear contrasts were included for each outcome variable and cumulative risk index, showing no interaction with intervention or dosage.

Conclusions: We found that a low-intensity primary care-based intervention using finger puppets to promote positive parent-child interactions in infancy was associated with enhanced aspects of the cognitive home environment and better preverbal and receptive language at 12 months, especially for families who used the puppet daily.

P2-G-372 - Development of language separation and awareness in young bilinguals: evidence from parent report

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Details

Infants raised in bilingual communities face the challenge of learning two languages in complex sociolinguistic environments. To succeed, they must build separate linguistic systems and use them in a context-appropriate manner. From very early on, infants auditorily discriminate between different languages (Bosch & Sebastián-Gallés, 2001; Byers-Heinlein et al., 2010). They prefer listening to native languages (Byers-Heinlein et al., 2010; Moon et al., 1993) and interacting with native speakers (Kinzler et al., 2007). Later on, they develop pragmatic differentiation and use the appropriate language with each speaker (Genesee et al., 1995; Lanza, 1992; Nicoladis, 1998). As children grow older, they start explicitly expressing their language knowledge, for example, by labeling their own languages (Akhtar et al., 2012). Even though these markers emerge at different times, no study to date has examined how they might interconnect throughout development. The main objective of the current study is to describe the underlying structure and the developmental trajectory of language separation and awareness in bilingual children, along with three potential predictors: age, family language strategy (e.g., one-parent-one-language), and family linguistic reflections (i.e., explicit metalinguistic talk about languages). We created an online questionnaire collecting parent-report measures of 28 items covering behaviors related to language separation and awareness in young bilinguals. To date, data have been collected from 81 Catalan-Spanish bilingual children aged 1-5 years growing up in Catalonia (Spain). An Exploratory Factor Analysis revealed three underlying factors: 1) Language Labeling (e.g., being able to say that a person speaks Spanish), 2) Pragmatic Differentiation (e.g., using an appropriate language for different speakers), and 3) Language Preference (e.g., preferring to speak one language over another). We computed scores combining the items that loaded into each factor and analyzed their relation with the potential predictors. For age, the correlation was very strong with Language Labeling ($r = .85$, $p < .001$), strong with Pragmatic Differentiation ($r = .63$, $p < .001$, note the qualitative change around age 2 in Figure 1A) and weak with Language Preference ($r = .24$, $p = .03$). Similarly, family linguistic reflections showed a strong correlation with Language Labeling ($r = .63$, $p < .001$), moderate with Pragmatic Differentiation ($r = .42$, $p < .001$) and weak with Language Preference ($r = .24$, $p = .03$). Surprisingly, family language strategy did not predict the score of any factor, suggesting it may not play a role in language separation and awareness development. Our findings support the idea that language separation and awareness is a multidimensional construct that develops as children age, which is consistent with and expands on previous research. While family language strategies such as one-parent-one-language have traditionally been considered to affect language separation and awareness, our results suggest that age and family linguistic reflections may be more important. Our results also represent a methodological advance highlighting the potential of parent reports in examining language separation and awareness. Data collection is ongoing in a population of French-English bilinguals in Quebec (Canada). Results across the two populations will be compared to explore whether and how linguistic and sociocultural differences affect language separation and awareness.

P2-G-373 - Impact of age and race on face recognition in 9- to 12-month-olds

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Details

Background: Perceptual narrowing leads to processing biases for perceptual categories infants are exposed to regularly in their first year (e.g., Kelly et al., 2007; Machi Cassia et al., 2014). By 9 months of age, infants show improved recognition of own-race compared with other-race faces, and of adult faces compared with child faces, reflecting increased experience with these stimuli (Kelly et al., 2007; 2009; Machi Cassia et al., 2014).

Objective: The current study examined the potential interactive effects of perceptual categories on face recognition ability after perceptual narrowing has occurred, by evaluating the impact of race and age simultaneously on face recognition 9- to -12-month-old infants.

Method: Sixty-three 9- to 12-month-old infants participated in the online study asynchronously via Lookit (see Table 1 for demographics). Participants were randomly assigned to an adult (n = 30) or child (n = 33) face stimuli condition, including own- and other-race faces. Participants were familiarized with an own- or other-race face and then completed visual paired comparison (VPC) trials including the familiar face and a novel face of the same race to measure recognition. The procedure was repeated with own- or other-race faces, so that each participant was tested for recognition of own- and other-race faces.

Hypotheses: We hypothesized that infants would only demonstrate recognition of familiar own-race adult faces. That is, in the adult condition, we hypothesized infants would demonstrate superior recognition of own-race faces compared to other-race faces, evidenced by a significant preference for the novel face during own-race VPCs and a null preference during other-race VPCs. In the child condition, we hypothesized that there would be null preferences in both the own- and other-race face conditions.

Data analysis: Bivariate correlations among all study variables were examined. Looking preferences in each condition were explored using paired samples t-tests comparing looking to the own-race familiar and novel faces, as well as the other-race novel and familiar faces.

Results: Paired samples t-tests revealed no novelty preferences, showing no evidence of face recognition in either condition for own- or other-race faces. For participants in the child-face condition, looking during other-race familiarization was correlated with looking to the novel-other-race face, $r = .365$, $p < .05$, and looking during own-race familiarization correlated with looking to the novel-own-race face, $r = .414$, $p < .05$.

Conclusions: These preliminary findings contrast previous literature in this area that finds both an adult and own-race bias in face recognition during infancy, warranting greater investigation into how experience may shape face recognition in the first year. Significant correlations in the child-face condition provide evidence of individual differences in recognition within our sample. The racial and ethnic diversity of our sample may have impacted these results, as infants from a minority racial identity may not present the other-race effect in the same way that majority race infants do. Additional data collection efforts are underway to allow us to further investigate individual differences. Future analyses will consider participant demographics, exposure to racial and ethnic diversity, and exposure to child faces in the home environment.

P2-G-374 - The influence of animacy on infants' goal representation of rational actions

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Details

Whether animacy is a prerequisite for infants' attribution of goals to objects is a hotly debated issue. The animacy hypothesis holds that the attribution of goals is reliant on animate entities from the motion or appearance of the object (Johnson, 2003; Luo & Baillargeon, 2005). An alternative account of rational action posits that infants make goal inferences by evaluating the efficacy and equifinal variations of object behavior under given situational constraints (Gergely & Csibra, 2003; Biro, Csibra, & Gergely, 2007). In the present study, we conducted an assessment of infants' expectation of an agent's goal choice to determine whether rational action was sufficient for goal attribution. Using a visual habituation method, 12-month-old infants (N = 48) observed computer-presented animations, where a circle jumped over obstacles of variable heights in order to reach a target object behind the obstacle. The circle's actions were rational in the sense that it contingently adjusted the height of the parabolic pathway pathway to match that of the obstacle. Half of the infants watched the circle display self-propelledness and launch without external forces (animate agent); the other half watched stick hit the circle which was then launched (inanimate agent). Following habituation, the target object was switched to the other side, and a new object was placed in the previous location. Infants saw the circle jumped over to the new object or to the old object. Figure 1 shows the schematic drawing of the events. The results revealed a significant main effect of order, F (1,44) = 5.23, p = .027, and a significant interaction of order and test event, F (1,44) = 4.43, p = .041, with no main effect of agent type nor any interactions involving agent, all Fs (1,44) < 1. Tests of simple main effects showed that infants looked longer at the old goal event presented first than that presented later, F (1,46) = 10.05, p = .003, they looked equally long at the new goal event across orders, F (1,46) < 1. Figure 2 shows the mean looking times for the old goal and new goal events and for the last three habituation trials as a function of test order. Infants consistently dishabituated to the new goal event whether it was presented first or latter, F (1,23) = 14.82, p = .001, and F (1,23) = 8.43, p = .008, respectively. They dishabituated to the old goal event only when it was presented first, F (1,23) = 22.90, p < .001, but not later, F (1,23) < 1. Infants thus responded systematically to goal changes after introduction of a new target, even if the agent did not exhibit unambiguous animacy cues and no choice between two targets was involved in the habituation. In line with the rational action theory, our results suggest that context-sensitive behavioral cues are sufficient to support attribution of goals to objects in 12-month-old infants.

P2-G-375 - Individual differences of spatial learning in infancy: How spatial play and language contributes to spatial skill development

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Details

Spatial ability is the capacity to reason about visual and spatial relations between objects or spaces and is a known predictor for STEM achievement (Uttal & Cohen, 2012). It is important to understand how to best support the development of spatial skills prior to formal schooling. Past research has shown that sex differences in spatial skills are already present in infancy and grow stronger into childhood and adulthood (Lauer & Lourenco, 2016). In preschool children, spatial language, including input, comprehension, and production, has been shown to predict spatial competency, as exposure to spatial language can help children encode spatial features and relations (Pruden et al., 2011). This present study explores individual differences in parent engagement and language during play with their infant.

The present study investigates parent-child dyads' approaches towards play with a spatial toy. We studied 99 parent-infant dyads (mean infant age = 11.21 months, SD = 0.37) during a 5-minute freeplay session with a spatial shape sorter toy. Parents then completed a questionnaire about their infant's motor development, language comprehension and production, frequency of play with different types of toys, and their own beliefs about play. Coders transcribed the videos to investigate differences in dyad play types and spatial language use. We hypothesize that parents will use more spatial language during spatial play (e.g., shape-focused and block building play) compared to non-spatial play (e.g., color-focused and motor play). Given that previous research finds evidence for early sex differences in play (Lauer et al., 2018), we also investigate whether parent play style and spatial language input varies by child sex.

Preliminary analyses were conducted on 33 dyads, which will be used for pre-registration. The most common type of play among both parents and children was motor play (e.g., throwing, rolling, and/or kicking the shape sorter toy/blocks) and the second most common type was block building play (e.g., stacking and organizing blocks to create a structure) (Figures 1 & 2). Parents' engagement in different types of play did not differ by sex of the child. Parents indicated that, on average, they believe in and support the importance of play with their infant (M = 4.16/5, SD = 0.34) and did not believe that academically oriented activities were more important than play in their infant's development (M = 1.52/5, SD = 0.28). Future analyses will relate these findings to differences in dyads' participation in interactive play (i.e., when parent and infant are engaging in the same type of play) and independent play (i.e., when parent and infant are engaging in different types of play, typically when the parent suggests a type of play and the infant chooses to engage in something else). Next, we investigated whether parents altered their spatial language use across different play conditions. However, spatial language input did not vary as a function of play type or infant sex.

Future analyses will investigate how differences in infants' motor development and parents' perceptions towards play influence parents' spatial language and play. The main analyses will use the additional 64 dyads already collected. These results will provide support for the foundational role of parental engagement and language input on early spatial development and could inform future interventions to improve spatial skills, and, in turn, STEM outcomes.

P2-G-376 - The BabyGlucoLight clinical trial: The impact of glycemic control on neurodevelopmental outcome in very preterm infants

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Details

Neonatal hypoglycemia is common and can be associated with adverse neurodevelopmental outcomes, and this is particularly true in very preterm (≤32 gestational weeks) compared to full-term infants (Alsaleem et al., 2019). Thus, hypoglicemic events should be diagnosed and treated timely. Unfortunately, the impact of glycemic changes on neurodevelopmental outcome and their management is still controversial. Several studies showed a link between glucose levels and brain hemodynamic (Aslin et al., 2015), but no study on glucose control has considered so far the brain into the picture since birth. The ongoing BabyGlucoLight clinical trial aims to assess the impact of glucose changes and tight glycemic control on brain hemodynamics and neurodevelopmental outcome in very preterm babies, performing a continuous multi-modal acquisition during the first week post-partum of brain hemodynamics with diffuse optical tomography (DOT), and glucose changes with continuous glucose monitor (CGM). The advancement of CGM has allowed for the development of core metrics such as Time in range for glycemia. We hypothesize improved cognitive, motor and language outcome, as well as visual attention and memory, at 12 months and 24 months of corrected age in very preterm babies exposed to CGM in the first week of life, compared to controls.

Sixty very preterm newborns (≤ 32 gestational weeks or ≤ 1500 gr birthweight) were enrolled so far at the Neonatal Intensive Care Unit of Padova University Hospital. CGM and DOT were placed on the babies within 48 hours from birth and kept on site for a maximum of 5 days. Babies were randomized 1:1 to either an unblinded group (CGM alarms on and physicians could modulate glucose intakes based on real-time values) or a blinded group (CGM alarms silent and newborns received current standard of care measurements of glucose levels twice a day). Additional 30 full-term infants are enrolled as a control group. Babies were followed up at 12 and 24 months of corrected age, with the administration of the Bayley Scales of Infant and Toddler Development (BSID-III), and two computerized tasks for the investigation of disengagement of visual attention (Gap-Overlap task, Cousijn et al., 2017) and visual short-term memory (Continuous stream change detection task, Beckner et al., 2020).

Here we report data on the effects of the glucose variability at birth on neurodevelopmental outcomes at 12 months in 32 very preterm infants compared to controls. As for the BSID-III, results show that, although the language domain was significantly poorer for very preterm infants compared to controls ($p<0.001$), there was an improved outcome in such domain for infants with the lowest glycemic variability at birth ($p=0.012$). Further, infants with highest percentage of Time in Range for glycemia at birth demonstrated better attentional disengagement capabilities in the Gap-Overlap task ($p=0.007$), with performance like those of the infants in the control group.

Overall, these data, even if not conclusive due to the ongoing nature of the project, highlight the importance of monitoring brain hemodynamics from birth to improve clinical care of very preterm babies at birth and during early development.

P2-G-377 - Caregiver inhibitory control, caregiving behaviours, and infant visual cognition

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Details

Objectives: Caregivers play a significant role in shaping children's early cognitive development. Previous work has shown that caregiver cognition can predict child cognitive development at 24 months. Similarly, work on caregiving behaviours, e.g., intrusiveness, has reported that both caregiver cognition and caregiving behaviours account for unique variance in child cognitive functions at 36 months. However, it is unclear if there is an impact on child cognition as early as the first year of life. In the current study, we investigated whether inhibitory control in caregivers, an important executive sub-function linked to socio-emotional regulation, was associated with visual cognition in their infants. We also inquired whether caregiving behaviours during dyadic interactions between caregivers and their infants were associated with caregiver inhibitory control and infant visual cognition.

Methods: 88 caregivers (33.4 ± 4.4 years) and 86 infants (250.6 ± 35.8 days) participated in the study. To assess inhibitory control, the caregivers completed a Go-NoGo task. Caregivers had to either elicit or inhibit a response for four separate stimuli. An efficiency score was calculated for each caregiver by dividing the average reaction time across both responses by the rate of correct responses to provide an index of processing efficiency such that higher scores indicated more efficient performance. To assess visual cognition, infants were presented with a preferential looking task. In this task, two side-by-side displays of coloured shapes flashed on and off. On the 'unchanging' side, the colours were always the same and on the 'changing' side, a random shape changed colour after each flash. VWM load was manipulated by presenting 1 (low), 2 (medium) or 3 (high) items. Change preference (CP) scores were extracted by calculating preference the infant displayed towards the changing side. Functional near-infrared spectroscopy was used to record brain activation from caregivers and infants as they engaged in their respective tasks. To assess caregiving behaviours, we coded intrusiveness and scaffolding behaviours from 5-7-minute-long videos recordings each of two bouts of dyadic interactions.

Results: Our findings revealed that there was no direct association between caregiver efficiency and infant CP score. Instead, we found an indirect association - caregiver efficiency was linked to infant CP score through left-lateralized fronto-parietal engagement. Specifically, infants with low efficiency caregivers showed decreasing left-lateralized parietal engagement with increasing CP score performance at the medium and high loads compared to infants with high efficiency caregivers, who did not show any load- or performance-dependent modulation. Finally, we found associations between caregiver efficiency and caregiving behaviours. Specifically, there was a positive relationship between caregiver efficiency and scaffolding; such that higher efficiency during the task was associated with a higher frequency of scaffolding behaviours during dyadic interactions. There was also a negative relationship between caregiver efficiency and intrusiveness; such that higher efficiency during the task was associated with lower intrusiveness during dyadic interactions. However, we found no direct association between any caregiving behaviours and infant visual cognition.

Conclusions: Our findings contribute to a growing body of literature examining the role that caregivers play in early neurocognitive development.

P2-G-378 - Anticipatory looking patterns in monolingual and bilingual infants: Does stimulus presentation side matter?

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Details

Controlling one's attention when presented with competing stimuli in the environment is a cognitive skill developed early in life. Environmental factors have been proposed to influence the development of this skill, such as the variability in an infant's linguistic environment, particularly related to early bilingual experience. That is, previous studies have suggested that bilingual infants' experience with co-activating two languages may lead to stronger attentional control abilities compared to monolinguals, but these effects have not been demonstrated consistently in the literature. Most of these studies have implemented anticipatory eye movement (AEM) tasks during which infants are required to anticipate the location of a visual target on one side of the screen for half of the trials (pre-switch phase), and then on the opposite side for the remaining half (post-switch phase). Thus, this task relies on participants responding to a visual target presented to either their left (LVF) or right visual field (RVF), which are considered to be processed by contralateral brain hemispheres (right or left, respectively). Using attentional paradigms with adults, previous research has suggested that early bilingual experience may also lead to different hemispheric engagement when responding to external stimuli. Particularly, bilingual adults exhibit different hemispheric lateralisation to monolinguals when presented with visual information in the LVF. However, it remains unknown whether similar lateralisation effects already emerge in response to target side presentation in infant populations.

Therefore, AEM tasks could also offer valuable insights into the neural underpinnings of attentional processes, based on the differential pattern of responses to stimuli presented in the RVF or LVF. To test this possibility, we re-analysed three open datasets (Dal Ben at el., 2022; D'Souza et al., 2020 &; Kalashnikova et al., 2020) that employed variations of an AEM task to determine (1) potential monolingual-bilingual differences in attentional processing, and (2) whether these patterns are influenced by the side of visual target presentation (left or right), which would shed light on potential hemispheric asymmetries in attentional processing across the two groups. Re-analysis of infants' anticipatory gaze proportions to the expected target location revealed a target side effect in only one of the three datasets. Specifically, in the pre-switch phase, monolinguals showed significantly higher gaze proportions compared to bilinguals when the target reward appeared in the RVF, while there were no group differences for the LVF and no target side effects for the post-switch phase. Despite an LVF advantage often being reported in attentional processing tasks, the RVF effect observed here offers evidence supporting the notion that the RVF might receive more attentional resources as a result of both hemispheres directing attention to the RVF, and only the right hemisphere directing attention to the LVF. These results will be discussed further in terms of attentional processing differences between monolingual and bilingual infants during visual tasks. Finally, this study highlights the importance of accessibility to open data, as well as the need for developing paradigms that are more suitable for investigating hemispheric differences behaviourally in infant populations.

P2-G-379 - Developmental change in the value systems for reward and information: An EEG-MVPA cross-sectional study

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Details

Recent research has examined how the drive for information shapes attention allocation and exploratory behaviors from early infancy (Poli et al., 2020; Ghilardi et al., 2023). While seeking information and seeking rewards rely on and activate a similar underlying neural architecture (Kobayashi & Hsu, 2019), a considerable degree of independence from each other is reported in human adults (Cogliatti-Dezza et al., 2022). This suggests that reward and information represent distinct signals, with information being valuable on its own. However, whether information and reward are processed as overlapping or distinct signals from early in infancy remains an open question.

This study investigates developmental changes in the systems encoding reward and information value. Specifically, it explores whether these systems start as unitary and specialize across development or whether they begin as independent systems that later converge to some degree. We aim to test 50 typically developing seven to eight-month-old infants and 50 adults in a combined EEG-eye-tracking associative learning task. Participants will be presented with 240 (adults) and 40 (infants) cue-target trials where cues can be informative or non-informative about the target location, and targets can be rewarding or non-rewarding (Figure 2). This 2x2 combination of cues and targets generates four trial types (information: informative/non-informative and reward: rewarding/non-rewarding). The cue shape and color is predictive of the trial type. Each trial, the cue appears at the center of the screen and then moves to one of 14 locations on screen. In informative trials, the cue location signals the location of the subsequent target, while in non-informative trials it does not. In rewarding trials, the mother's face (infants) or a face previously associated with earning money (adults) is presented as target. In non-rewarding trials, a stranger's face (infants) or a face not associated with monetary reward (adults) is shown (Figure 1).

When examining the response to the cue, we can orthogonally separate the main effects of information and reward anticipation processing using time-resolved multivariate pattern analysis (MVPA). MVPA is an advanced technique to identify brain activation patterns for specific experimental conditions (Haynes & Rees, 2006), and has recently been implemented with infant EEG data (Ashton et al., 2022). We will employ MVPA to decode the distinct patterns of neural activity related to the two main effects, reward and information anticipation, in the infant and adult data. Subsequently, using representational similarity analysis (RSA) we will compare the degree of similarity between the patterns of neural activity across value systems (reward vs information) and age groups (infants vs adults) (Figure 2). A strong overlap between the two systems in infants compared to adults would suggest a unitary developmental profile with one system that increasingly specializes during development. A higher degree of

independence between the systems in infancy compared to adulthood would suggest that the two systems have different functions initially and only increasingly overlap through interaction (i.e., the association of information with reward access) across development. Adult EEG data is being collected and infant data collection will be carried out between January and May 2024.

P2-G-380 - Infants' representation of causal launching is bounded by approximate Newtonian constraints on elastic collisions

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Details

In the classic Michottean 'launching' event, an object A moves until it is adjacent with an object B, at which point A stops and B immediately starts moving in the same direction with comparable speed (Michotte, 1946/1963). This event corresponds to a real-world Newtonian elastic collision (e.g., a billiard-ball collision). Previous work has found that, by 6-8 months of age, infants habituated to launching events will dishabituate to events that defy approximate real-world Newtonian constraints on elastic collisions, such as spatiotemporal contiguity (i.e., A contacts B, B's movement follows immediately from contact; Cohen & Amsel, 1998) and the relative speed of B's motion following the collision (Kominsky et al., 2017). The constraint in the latter case is somewhat unintuitive: Regardless of the relative mass of A and B, object B can never move faster than double the speed of object A based on the force of the collision alone. Michotte described events in which the speed ratio A:B exceeded 1:2 as 'triggering' events, in which the motion of B is autonomous (i.e., the manner in which B moves is independent) but not spontaneous (i.e., B's movement is still initiated by contact with A) (Michotte, 1946/1963). However, it is unclear whether infants actually represent these 'triggering' events as causal at all, simply regard them as 'not launching', in the same manner as spatial or temporal offset events that defy other Newtonian constraints. To distinguish these possibilities, we built on previous work showing that 6-month-olds are sensitive to situational causal roles in launching events: If habituated to A launching B, they dishabituate to B launching A, but they do not dishabituate to the reversal of non-causal events with a spatial or temporal offset (Leslie & Keeble, 1987; Bélanger & Desrochers, 2001). Experiment 1 was a 2 (A:B habituation speed ratio 3:1 vs. 1:3) x 2 (motion-on-contact vs. delay) fully between-subjects design based on this role reversal paradigm, with 16 infants age 6.5-7.5 months in each cell (total N=64). Infants were habituated to an event in which A contacted B, and B either moved immediately or after a short delay (between subjects). Furthermore, this habituation event could either have a speed ratio that was compatible with Newtonian constraints on elastic collisions (3:1) or one that defied those constraints (1:3). At test, infants saw a 1:1 event in which B contacted A. We found a main effect of motion-on-contact vs. delay (p=.014) but no effect of or interaction with habituation speed ratio (ps>.18). However, infants in the 1:3 condition may have dishabituated simply because the test event was a 1:1 launching event. Therefore, in Experiment 2, we used 1:3 events for both habituation and test, and varied between-subjects whether the events were motion-on-contact or delay (n=30 6-8-month-old infants per condition, total N=60). We found no effect of motion-on-contact vs. delay in this experiment (p=.79), indicating that infants are not sensitive to situational causal roles in triggering events. This indicates that triggering is at least not represented as the same kind of causality as

launching, but may also indicate that in general, the causal representation of 'launching' in infancy may be bounded by approximations of Newtonian constraints on elastic collisions.

P2-G-381 - Multimodal caregiver involvement during dyadic interactions mediates the association between caregiver and infant visual cognition

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Details

Objectives: Cognitive development in children is guided by social interactions with their caregivers. It is not fully understood how caregiver visual cognition impacts their child's ability to sustain and shift attention, and ultimately, detect change in the world around them. To address this gap, the current study posed two research questions. First, we inquired whether there was an association between caregiver and infant visual cognition. Second, we inquired how caregiver involvement during dyadic interactions with their infant mediated this association.

Methods: 86 infants (250.6 ± 35.8 days) and 80 caregivers (33.25 ± 4.37 years) participated in the study. To assess visual cognition, both infants and their caregivers were separately presented with age-appropriate variants of a preferential looking task. In this task, two side-by-side blinking displays of coloured shapes are presented; on one side, one shape randomly changes colour during each flash and on the other side, the colours of the shapes remain the same. For infants, memory load was manipulated by presenting 1 (low), 2 (medium) or 3 (high) shapes and for caregivers, memory load was manipulated by presenting 4 (low), 6 (medium) or 8 (high) shapes on each side. Functional near-infrared spectroscopy (fNIRS) was used to record brain function from caregivers and infants. From the looking behaviours, we estimated a change preference (CP) score, a measure of preference for the changing side. Image reconstruction was used to analyze fNIRS data. To assess caregiver involvement during dyadic interactions, we coded object-associated looking, touching and verbalization behaviours from 5-7-minute-long video recordings of caregivers and infants playing with toys. Linear mixed effects modelling and mediation analyses were used to investigate the association between caregiver cognition, infant cognition, and caregiver-infant interactions.

Results: For both caregivers and infants, CP scores decreased with increasing memory load load, and CP score at the low load was significantly greater than CP score at the medium and high loads. Linear modelling revealed that higher CP score in caregivers was associated with higher CP score in infants at the low load. Further, brain analyses revealed that higher CP score in caregivers was associated with greater left superior parietal lobule activation in infants, a region associated with visual working memory maintenance. During dyadic interactions, caregivers displayed either unimodal (looking), bimodal (looking and touching) and multimodal (looking, touching and verbalization) behaviours when engaging their infant with toys. Interestingly, caregiver multimodal behaviours (and not unimodal or bimodal) partially positively mediated the association between caregiver CP score and left superior parietal lobule activation in infants.

Conclusions: Our findings inform how caregiver cognition is associated with infant cognition in the first year of life. Further, they reveal that multimodal caregiver engagement involving looking, touching and verbalization behaviours about objects during dyadic interactions with their infants mediates this association.

P2-G-382 - Odd or not? Examining 14-month-old infants' nonverbal category knowledge in a pupillometric oddball paradigm

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Details

To navigate complex environments, infants are challenged with organizing their sensory input from early on. Successful object categorization draws on two processes: 1) individuating objects based on a set of contrasting perceptual features (Meltzoff & Moore,1998; Spriet et al., 2022) and 2) generalizing across objects that share conceptual and perceptual features (Xu, Carey & Quint, 2004; Oakes & Madole, 2008). Although object categorization in infancy has been studied extensively (Pauen, 2002; Quinn & Tanaka, 2007; Pomiechowska & Gliga, 2021), our current understanding of infants' strategies in exploiting featural information is still lacking. While perceptual categorization has been reported from 4 months on (Behl-Chadha, 1996; Mareschal & Quinn, 2001; Spriet et al., 2022), conceptual organization is argued to emerge later, starting at 10 months (Träuble & Pauen, 2007; Spriet et al., 2022; Xu, Carey & Quint, 2004). However, in a study by Kibbe and Leslie (2019) 6-month-olds notably remembered categorical but not perceptual identities of hidden objects.

In the current study, we explore nonverbal, knowledge-based object categorization in 14-month-olds. We expand on existing work in several ways. First, we explore the use of pupillometry in a visual oddball paradigm (informed by Elsner, Jeschonek & Pauen, 2013). Specifically, we are interested in whether infants' pupil dilation responses capture perceptual and/or conceptual object differences and can be used as a proxy for category knowledge. In line with ERP findings, oddballs should yield greater pupil dilation to indicate cognitive effort upon processing divergence from the standard stimulus. Second, we integrate questions on object individuation and categorization in a single design by investigating infants' reactions to between-category as well as within-category changes. Third, our oddball paradigm comprises several categories and a large range of corresponding exemplars.

We exposed 14-month-old infants (N= 47) to 28 objects across four blocks (within-subject). Each block contained 18 object images belonging to two familiar categories (e.g. flowers and cars): 12 repetitions of the standard category stimulus (e.g. a specific red flower), 3 distinct within-category oddballs (e.g. a yellow sunflower) and 3 distinct between-category oddballs (e.g. a red car). In the beginning of each block, infants were familiarized with 3 standard stimulus repetitions. The remaining standard presentations were alternated with oddballs. Between-category oddballs were designed to be perceptually similar to the standard stimulus (yet conceptually different) and within-category oddballs to be perceptually different (yet conceptually similar). Each object appeared on the screen for 1500ms, enclosed by slow fade ins/outs and preceded by a neutral baseline. Luminance was kept constant throughout.

In ongoing linear mixed model analyses, we are investigating the effect of stimulus type on pupil response during object presentation. Contrary to our expectations, preliminary results indicate that standard stimulus presentation triggered greater pupil dilation ($p<.001$) than within- and between-category oddballs. Further analyses will probe the robustness of these findings, explore group differences (i.e. on the category level) and examine other factors that may be influencing infants' pupil responses in this experiment. Results will be discussed with respect to conceptual and methodological implications.

P2-G-383 - Do infants have access to quantified representations?

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Details

Natural languages provide a variety of means to express information about collections or groups of individuals such as conjoined phrases, plural noun phrases and quantifiers. But while plurals like "(the) boys" are known to allow for non-maximality, i.e. to tolerate exceptions, universally quantified phrases such as "all boys" or "each boy" usually come with the requirement of maximality (Križ, 2015). Moreover, universals may differ in their range of possible meanings when used to describe events that involve multiple individuals. In particular, "all" may receive a collective interpretation as in "All boys pushed a box (together)", whereas "each" is only compatible with a distributive interpretation as in "Each boy pushed a box (individually)".

Previous findings based on explicit truth-value judgements seem to suggest that both aspects, the maximality requirement as well as the collective/distributive distinction, pose difficulties for young language learners even beyond preschool age (Philip, 1996; Pagliarini, Fiorin and Dotlačil, 2012). On the other hand, there exists initial evidence stemming from implicit measures indicating that already pre-verbal infants may deploy quite abstract concepts when encoding regularities in their environment, for instance relational concepts such as SAME (Kovács, 2014; Hochmann, Carey and Mehler, 2018) and negation (Dudley, Kovács and Téglás, 2023). In the present study we aim to explore further the early availability of abstract representations and to investigate whether infants may encode events that involve a group of agents acting collectively upon an object in a goal-directed manner in terms of their quantificational properties.

11-month-olds are presented with a series of video animations showing multiple agents pushing a box together towards a centrally positioned goal which is flanked by an object on each side. In the learning phase, infants watch either a maximal (e.g. 3 out of 3 agents contribute to joint goal achievement) or a non-maximal (e.g. 2 out of 3 agents participate in the joint action) event such that the maximal/non-maximal character is predictive for the rotation of the lateral objects. During the test phase, we ask whether infants can generalize the rule to new cardinalities that were not present in the learning phase and predict the rotating event based on the quantifier picked up in the preceding phase. Test scenes show maximal collective events that involve the same number of agents as in the non-maximal learning event, but the same quantificational properties as in the maximal learning event (e.g. 2 out of 2 agents acting jointly). Thus, predictions can be guided either by the numerical properties of the scene (as in

„Two boys pushed a box“) or based on universal quantification (as in „All boys pushed a box“). First looks and cumulative looking time towards the ROIs including the target objects are measured and will be analyzed with t-tests. Data collection is still on-going and will be completed by the time of the conference. The design and planned analyses were preregistered: https://aspredicted.org/QH37NQ.

If infants encode the events in terms of their quantificational properties, this would suggest that, before mastering the truth-conditions of verbal quantifiers, they have access to universally quantified representations. If however infants' anticipatory looking behavior is better explained by the numerical properties of the events, this may be taken as evidence for language playing a critical role in the development of such representations. Our findings may therefore inform theories of language acquisition and contribute to the growing body of research on logical capacities in infancy.

P2-G-384 - Exploring food learning cues in 12-month-old infants

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Details

Food learning in early life largely relies on social learning (Shutts et al., 2013). Previous research has shown that children learn that a food is safe to eat when they directly observe someone else eating that food (e.g., DeJesus et al., 2018). However, the impact of other forms of food-related social information on food learning remains largely unknown. One form of social information is food processing (e.g., cutting a carrot). Food processing techniques have been an important part of human food consumption for millennia and often reduce the toxicity of raw foods. Food processing techniques also often require individuals to handle food items in some way. Accordingly, cues of food processing may act as signals that a candidate food item is safe to touch and eat. In fact, recent work suggests that infants are more willing to approach foods that bear markers of processing compared to unprocessed foods (Rioux & Wertz, 2021).

The current study investigates whether infants view cues of food processing (e.g., cutting a root vegetable) as an indicator of edibility. To test this, 12-month-olds (N = 65, evenly divided into three between-subject conditions) watched side-by-side videos of an actor performing one action on one type of novel food (a purple carrot) and a different action on a different type of novel food (a white parsnip). We examined three types of actions across conditions: eating, cutting (a food processing action), and touching (a low-level control action; see *Figure 1*). The actions were played in alternation and the pairing differed across the three conditions: (1) Eating vs. Touching, (2) Cutting vs. Touching, and (3) Eating vs. Cutting. Infants' gaze was recorded with an eye-tracker to determine (i) the actions they prefer to attend to and (ii) their pupil dilation, which indicates arousal (Mathôt, 2018). After the action presentation phase, infants were presented with a choice between the two root vegetables shown in the videos and asked "*Which one can you eat?*" We recorded infants' first visually-guided reach as their choice.

We predicted that infants will (1) exhibit longer looking times and increased pupil dilation when attending to the food-relevant actions (Eating and Cutting) compared to the control action (Touching), and (2)

choose the novel root vegetable shown in the food-relevant action videos. In addition, if infants view food processing actions as indicators of edibility, we expect no systematic differences in the Eating vs. Cutting conditions. Data collection is completed, but our analyses are currently ongoing. A preliminary coding of the choice data suggests that, as predicted, infants use eating actions to infer edibility and may treat eating and cutting actions similarly when they are presented side-by-side (see *Figure 2*). Our ongoing analyses of our eye-tracking data will shed light on the attentional mechanisms underlying food learning in infancy, clarify the pattern of response we observed in our choice data, and reveal what forms of social information infants use to learn that a novel food is safe to eat.

P2-G-385 - The genesis of collaboration on ideas in children

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Details

As a Human species, collaboration has been crucial for our evolution—selected for, intertwined in learning, and essential for survival (Tomasello, 2022). Prior research indicates that toddlers engage in free play and can assist peers from their first year, but it is not until their third year that they fully grasp their obligations toward others and coordinate actions proficiently (Hepach et al., 2017). Furthermore, preschool children of all ages predominantly rely on nonverbal communication for collaboration (Endedijk et al., 2015; Yliverronen et al., 2018).

Drawing upon our systematic literature review of research around child collaboration, we notice that most studies focus on collaborating on practical tasks, such as engaging in joint activities or playing games (Young, 2008). But a highly significant domain of collaboration for humans is collaboration on *ideas.* If we come up with a plan together, we are not just collaborating on a practical action but on the creation of an idea – the plan; Similarly, collaborative refinement of a statement (you say that it's cold in Canada, I refine this by saying that it's cold but not all year – only in the winter), reflects a joint effort in honing a shared belief. An open question in the literature on child development, then, is the age at which children come to collaborate not just on practical actions (like planting a flower), versus collaborating on 'ideas'. Extant literature suggests that this transition may align with the acquisition of linguistic proficiency necessary for expressing and discussing reasons and ideas (Hartwell et al., 2022). This would imply that collaborating on ideas depends on language, thereby lending support to the 'language first' theory of reasoning (O'Madagain and Tomasello 2021).

Here we investigate the question at what age children develop competence with collaborating on ideas. To this end, the study employs a physical game, "Train and the Bridge," which evaluates collaboration within child dyads. It involves Player 1 controlling the bridge and Player 2 moving the train, requiring their cooperation to finish the task. The game encompasses two levels: Level 1 being the Collaboration on practical actions and Level 2 involving Collaboration on creating a plan (Figure 1). Besides attempting to pinpoint the age when children begin collaborating on ideas with their peers, we also aim to examine the mechanisms underlying the development of these skills.

In our pilot data, participants were 47 preschool children forming 82 dyadic groups engaged in both levels. We used a binary variable to code success (yes/no) based on task completion. Preliminary findings highlight the significance of dyad age (mean age of both children in the pair) as a predictor for success in both game levels, as illustrated in Figure 2. This is confirmed by the results of a model taking into account age differences between the children in the dyad; As the mean age of dyads increases, the likelihood of collaborative success also increases ($z = 2.795$, $p < 0.01$).

P2-G-386 - Toddlers root for their own gender when watching mixed-gender conflicts

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Details

For humans, dominance hierarchies play a major role in structuring relationships between individuals. Given their social importance, from very early on, children use a variety of physical cues to make predictions about who is more likely to be dominant or to win a conflict. For instance, even preverbal infants use physical size as a cue to dominance and they expect a larger agent to win over a smaller agent in a dyadic zero-sum conflict (Thomsen et al., 2011). Aside from individual characteristics, children's predictions are also based on the social category individuals belong to. For instance, 4-year-old children begin to represent gender hierarchically, and are more likely to associate power with males than with females (Charafeddine et al., 2020; Mandalawayla & Rhodes, 2020; Reyez-Jaquez & Koenig, 2022; Santhanagolapan et al., 2022). Other studies found own-gender biases, particularly when target characters were gendered (Charafeddine et al., experiment 3), or when children expressed their leader preferences (Reyez-Jaquez & Koenig, 2022). Here we used zero-sum conflicts to investigate if toddlers also have gender-based outcome expectations.

We presented 18- to 36-month-olds (N = 62 children; 30 girls) with videos of two pairs of adults engaging in non-aggressive zero-sum conflicts. Toddlers saw two mixed-gender trials (i.e., one woman and one man), which started with a familiarisation phase of each individual, a conflict phase, where they saw the two individuals in a zero-sum conflict (over a book or a chair). Finally, they saw the outcome of the conflict: for each participant in one trial the male won and in one trial the female won. In the test phase, toddlers were exposed for a duration of 40 seconds to a static image of the outcome. Analyses on the Proportion Total Looking Time to the winner, revealed a significant main effect of Winner Gender ($p = .012$), as children looked longer at the winner when it was a female than when it was a male. Additionally, we found a significant interaction between Child Gender and Winner Gender ($p = .009$), showing the children looked longer at the winner when it was the opposite gender to themselves (see Figure 1).

First, our results suggest that when toddlers are presented with gendered individuals, they display a positive disposition towards those of the same gender as themselves, and they expect them to win in

zero-sum conflicts. Additionally, we found evidence suggesting a male-dominance association, as infants displayed longer looking times when the winner was a female, which may indicate their surprise. Interestingly, we found strong own-gender biases even though the videos that we presented were of adult actors, from a different age group from that of our participants. All in all, to our knowledge this is the earliest evidence of male to dominance associations, and of gender-based affiliative preferences for individuals of the same gender at such a young age.

P2-G-387 - Ten- to eleven-month-olds' crawling choices for 'more': Density v Number

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Details

Previous research showed that 10-month-old infants prefer to reach for sets with higher density when number is controlled for (Uller, Urquhart, Lewis & Berntsen, 2013) and in numerical contrasts in the small number (1 v 2) and large number ranges (8 v 16) when the ratio is 1:2 (e.g., van Marle & Wynn 2011, Xu & Spelke 2000; Stevens et al. 2007 with nonhuman primates). This capacity gets "finessed" as babies get older (for ex., a 2:3 in the small number range may be observed in young babies, but in the large number range [e.g., 8 v 12] it is accomplished slightly later).

The relationship between density and number is an intrinsic one, and to separate the two helps to understand the nature of the numerical representations that babies have. For example, there is a possibility that babies reach for the set containing objects that are closer together because they can touch with their little hands all the objects at once, whereas in the 4- fold choice, they can effectively only touch ¼ of the set. In addition to this question, we seem to still have limited evidence of infants' numerical choices when the numerical contrast sits in between the two numerical ranges above (e.g., 2 v 4, 3 v 6, etc). This is relevant for the study of the theoretical model proposed to underpin these capacities – Analogue Magnitude and Parallel Individuation.

Here we present two studies based on a methodology that puts the baby in the centre of a clock dial set up. In Experiment 1, sixteen 10- and 11-month-olds (Mage = 10;28) had a choice of two sets of three toy ducks with varying distances (ratio 1:4) displayed on the floor, on a clock dial, with the infant in the centre of the clock. The distance between (all of the) objects and the infant was exactly the same in both sets. Infants selected the set in which the ducks were closer together. These results seem consistent with those of Uller et al.'s (2013) that infants have a spontaneous propensity to go for sets when objects are closer together regardless of whether they can or not touch all of the objects in a set. In Experiment 2, we aimed to assess whether 10- and 11-month old babies will select the set with higher number in a 1:2 ratio with numerosities that sit in between the small number range and the large number range. Data from sixteen 10- to 11-month-old infants will be used in this study. Participants are in the midst of being recruited and tested. We hope to provide support for the existence of two systems of counting early in infancy. The entailments of such results are discussed.

P2-G-388 - Priming analog magnitudes facilitates cross-boundary number comparisons in 10- to 12-month-old infants

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Details

It is believed that two cognitive systems underlie infants' intuitive number abilities – the Analog Magnitude System (AMS) and the Object Tracking System (OTS). The OTS has a capacity of around 3 during infancy and is more prevalent in small number representation (numbers within capacity). The AMS is prevalent in big-number representation. These two systems fail to communicate during first year of infancy and result in the failure of cross-boundary number discrimination (3 as the boundary) (e.g., Feigenson & Carey, 2005). Only in very limited studies, infants can succeed cross-boundary discrimination (e.g. vanMarle & Wynn, 2009).

Two studies used a paradigm very similar to Feigenson & Carey (2005), in which the experimenter hid snacks one by one into two cups and asked infants to choose one cup, are conducted to further understand the development and relation of the OTS and the AMS in infancy. Study 1 tested 15-, 18-, and 21- to 24-month-old infants' performance in cross-boundary number discrimination of 1:4 (1 vs. 4 and 2 vs. 8) and 1:2 (3 vs. 6) ratios to try to portray the development trajectory of cross-boundary number discrimination. Study 2 added a priming manipulation before the cup-choosing task by displaying a plate of 10 Cheerios for 10 seconds to test if pre-exposure to numbers exceeding the OTS system can facilitate 10- to 12-month-old cross-boundary number discrimination of 1:4 and 1:2 ratios (1 vs. 4, 2 vs. 8, 2 vs. 4, and 3 vs. 6).

In study 1. 15-month-old infants did not succeed in any cross-boundary conditions (1 vs. 4: 9/16 choose large, 2 vs. 8 :10/16, 3 vs. 6 : 4/9, all $p > .05$). 18-month-olds reliably chose the larger amount in 1 vs 4 condition (12/16 infants, $p < .05$, one-tailed sign test), but not the 2 vs. 8 condition (9/16, $p > .05$). 21- to 24-month-olds reliably chose the larger amount in the 2 vs. 8 condition (12/16 infants, $p < .05$, one-tailed sign test), but not the 3 vs. 6 condition (3/8 chose the larger, $p > .05$) See Fig 1. The results showed that infants start to discriminate different cross-boundary number pairs gradually during year 2. The role of plural/singular morphosyntax in single vs. non-single discrimination and the development of the OTS and the AMS are discussed.

For Study 2, 10- to 12-month-olds reliably choose a large quantity in the 1 vs. 4, 2 vs. 8, and 2 vs. 4 conditions (1v4: 13/16 infants, $p = .01$; 2v8, 14/16 infants, $p = .002$; 2v4: 12/16 infants, $p = .038$, one-tailed sign test). While infants chose randomly in the 3 vs. 6 condition. (7/12, $p = 0.38$). See Fig 2. The results indicate that by simply exposing infants to a number exceeding the OTS capacity infants start to succeed in cross-boundary number discrimination at 10-12 months of age. The possibility of the AMS being primed by the display of a number exceeding the OTS capacity and enabling the AMS to override the OTS prevalent in small number discrimination is proposed.

P2-G-389 - Modulation of somatosensory processing by visual and auditory moving stimuli in newborns

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Details

As adults, when we experience auditory and visual motion towards our body we can precisely predict if, where, and when the moving object will touch us, and we can anticipate the tactile sensation that we will experience. Surprisingly, little is known about how this ability develops during infancy and childhood. Recently, we showed that already at 4 months of age infants' somatosensory evoked potentials (SEPs) were modulated according to whether the somatosensory stimulus was preceded by approaching vs receding visual motion (Orioli et al., 2023). The early appearance of this differentiated response raised the question of whether this crossmodal sensory capacity is established even earlier in development. We investigated this by exploring newborns' (9- to 40-days-old) electrical brain responses to predictable and unpredictable touches, where predictability is modulated by presenting visual or auditory motion approaching the body vs receding away from it prior to the tactile stimulus. We conducted two separate studies, differing in the modality of presentation of the motion stimuli: visual vs auditory. In both studies, we are presenting newborn infants with approaching and receding stimuli, followed by vibrotactile stimuli on their hands (Figure 1). Twenty-one newborns contributed data to the auditory study (6F) and 14 to the visual study (5F). An initial data quality check indicated substantial variability across participants in how the electrical response to tactile stimuli is distributed across the scalp, particularly in the visual study. Therefore, instead of comparing somatosensory evoked potentials (SEPs) in response to the tactile stimuli, we compared the electrical brain response in the different conditions using a Global Field Power index (GFP, Skrandies, 1990). By computing a spatial standard deviation of the electrical activity across the whole scalp, GFP allows to assess the brain's electrical fields independently from electrode locations or reference sites, and considering the data from all recording electrodes. In other words, it allows to identify the latency of evoked components associated with the occurrence of maximal synchronous neural activation. Results indicate that GFP following the somatosensory stimulus is modulated by the preceding direction (towards or away from the body) of auditory motion, but not of visual motion (Figure 1). It may be possible that such difference between modalities might be due to the fact that the experience of auditory approaching stimuli followed by tactile stimuli on the body could begin to be acquired prenatally, while the same kind of experience with visual stimuli is less likely to take place before birth. The present results, providing evidence of a differentiated response to touches following auditory approaching vs receding stimuli (i.e. predictable vs unpredictable touches) indicates that from very early in development humans are sensitive to the relationship between moving stimuli in the extrapersonal space and tactile stimuli on the body. Such sensitivity is likely to support the early development of a representation of the body that is situated in the environment.

P2-G-390 - Associations between Executive Functions and Intelligence in Development: A Systematic Review and Meta-Analysis

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Details

Executive functions (EF) and intelligence are abilities that play a fundamental role in different areas of life and show steep development in infancy and childhood. For example, intelligence in childhood is predicted by early childhood processing speed (Kavšek, 2004), which in turn is presumably influenced by EF. On theoretical grounds, memory updating can be considered a key component of EF, and working memory including updating is central to fluid intelligence. Despite disparate research traditions, one way to conceptualize EF would be to include its components into a hierarchical model of general intelligence (Jewsbury et al., 2016). Consistent with this view, empirical work has concordantly demonstrated a small to medium-sized positive relation between intelligence and EF in adulthood. The present preregistered systematic review and meta-analysis (https://osf.io/u4e25/?view_only=723a3f72fdf648d5a5be1deea72b8e7e) explores the roots of the relationship between EF and intelligence and their sub-components in development, including only individuals under 18 years of age. A systematic search was conducted in the databases PsycInfo and PubMed on September 21st 2022 and supplemented by a search for grey literature. *K* = 2149 studies were extracted and coded. Included are studies that examine a healthy sample under 18 years of age, measure the primary variables “intelligence” and “executive functions” as separate constructs and assess them with standardized behavioral instruments. For EF, separate meta-analyses with a conglomerate EF-measure and the hypothetical sub-components memory updating, inhibition and set shifting are conducted, taking into account only tests for sub-components that have been validated. A list of validated EF measures is currently being assembled for this purpose. For intelligence, separate meta-analyses are conducted employing the “g”-factor and fluid intelligence. Given the evidence of a positive correlation in adults, a positive correlation between EF and intelligence is expected for minors, and effects of moderators (type of measurement, age, and study quality) are also expected. Differences in correlations between the two intelligence measures and the three EF components are explored. Hypotheses are tested using a random effects model, and publication bias is examined employing the funnel plot, trim-and-fill, and Rosenthal´s fail-safe N. In a preliminary analysis, the data from *k* = 9 studies with *n* = 4,178 minors (3-17 years) were included in the model, resulting in a mean effect size of *r* = 0.45 [0.37,0.53] for the association between EF and the “g”-factor. Currently, double-coding of study inclusion and exclusion is being finalized. This meta-analysis will thus provide a test of the idea that similar relations between global EF and EF components on the one hand, and the g-factor of intelligence and fluid intelligence on the other hand, as in adult subjects can be observed in children and adolescents. Thereby, this study will clarify empirically the overlap between those two broad cognitive constructs spanning separate research traditions to further our understanding of infants' and children’s cognitive structure.

P2-H-391 - Effects of a program to strengthen positive parenting in a very low-income families: randomized controlled trial

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Details

Positive parenting promotes nurturing care for healthful child development (Jeong et al., 2022). Parenting programs in early childhood prevent children's mental health problems and violence against children by strengthening positive parental practices (Britto et al., 2015; World Health Organization, 2018). The INSPIRE: Seven strategies for ending violence against recommend the ACT- Raising Safe Kids Program as a strategy of parenting for reduce violence against children (World Health Organization, 2018). The present randomized controlled trial examined the effects of an evidence-based universal preventive parenting program (ACT Program) in a highly low-income sample. The sample comprised 661 caregivers of 0-to-3-years old children (51% boys/49% girls), distributed randomly into the intervention group (IG, n= 332) and the waiting-list usual care control group (CG, n= 339). The sample was recruited through the social protection services of the 17 municipalities in the State of Ceará (Northeast of Brazil, Low- to Medium-Income country). Caregivers mainly were mothers (91%), with self-declared skin color as "brown" (66%), high educational level (62%). The monthly income of 94% of families was less than U$ 206.00, and they received cash transfers from a public policy program of the government at the state- and federal levels. The ACT- Raising Safe Kids Program (ACT, American Psychological Association) was delivered in-group eight sessions by trained professionals of the services. Pre- and post-intervention assessments were performed using the ACT Scale (C-Communication, DP-Discipline Positive, and EBR- Emotional and Behavioral Regulation) and the Parental Sense of Competence (PSOC). An App was used for the randomization process and recording the assessments. Repeated measures mixed ANOVA was performed for between- and within-group comparisons. The significance level was 5% ($p \leq 0.05$). The results showed statistically significant interactions between group (IG *vs.* CG) and time (pre-intervention *vs.* post-intervention), demonstrating that after participation in the ACT Program. The IG mothers improved significantly on emotional and behavioral regulation practices and parental sense of competence from pre-assessment to post-assessment, compared to the IG mothers ACT Scale-EBR, group*time = $p \leq 0.015$); PSOC, group*time = $p \leq 0.006$). In conclusion, the ACT Program demonstrated efficacy with very low-income families of children at early childhood in a large-scale implementation joined with public policies.

P2-H-393 - Maternal and infant Oxytocin are linked to EEG, stress, and temperament in infants of depressed and non-depressed mothers

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Details

Stress and depression are believed to neurologically program fetal and infant regulatory tendencies (Gartstein & Skinner, 2018). Human studies bridging the investigation of prenatal and postnatal bio-hormonal environments are minimal yet these may be imperative to understanding developmental trajectories. The neurohormone oxytocin (OT) is related to the developing infant socio-emotional and mother-infant affiliative behaviors (Jones & Mize, 2022; Ziegler & Crockford, 2017). In the current study, we examined maternal urinary OT levels as well as infant neurohormone levels and their influences on individual differences in infant temperament, EEG asymmetry, and mother-infant attachment formation.

We explored the links between maternal and infant neurohormones, in addition to investigating the associations and casual trajectories of neurohormones and neurophysiological profiles in relation to infant temperament, maternal mood, and attachment. 64 mothers provided prenatal urine samples during their third trimester (between 29- and 38-weeks' gestation) and again at 4 months postnatally. Mothers also answered questions about their depression symptoms, attachment/bonding patterns during prenatal and postnatal periods (newborn and 4 months), and infant feeding. Oxytocin was collected twice in infancy along with mother-infant behavioral interactions, EEG activity, and stress-cortisol responses at 4-months. Our analyses examined patterns of responsivity and regulation in families with and without mental health risks. Initially we noted that maternal OT was associated across time, $r = .62$, $p < .001$, while infant OT was not significantly related and had a high degree of variability across time. In addition, prenatal maternal depression and stress were significantly positively associated, $r = .33$, $p = .01$. and prenatal depression persisted stably into infancy, $r = .31$ to $.65$, $p < .05$. Infant OT during the initial postnatal period was not associated with maternal depression yet was associated with temperamental measures of inhibitory control at 4 months postnatally, $r = .74$, $p = .015$. Infants with higher OT levels also had significantly higher anterior asymmetry scores at central sites, $r = .79$, $p = .034$, suggesting the relation between OT and left hemisphere activity and a potential shift toward greater anterior activity by 4 months. Moreover, infant OT levels were negatively correlated with cortisol levels after a stressor task, $r = -.37$, $p = .011$, and vocal reactivity, $r = -.53$, $p = .020$, suggesting relationships between OT, stress responsivity and temperament. Finally, and unexpectedly, prenatal maternal attachment measures were not able to be predicted from OT in mothers nor infants, however, regression analyses demonstrated that postnatal maternal depression measures and OT levels predicted 18% of the variance in attachment/bonding measures, with depression exhibiting stronger predictive scores than depression, $p < .05$ than for OT but $p = .15$ for OT (Table 1). Links between prenatal and postnatal bio-hormonal risk, and early manifestations of temperament are important to examine in their own right; however, exploring their effects on early infant brain and temperament development illuminates the potentially enduring biological foundations of socio–emotional development in normative and at-risk families. Connections between neurohormones and cortical correlates will be explored in further analyses, specifically how they relate to bio-behavioral trajectories.

P2-H-394 - Maternal perceived stress in times of crisis – The protective role of couple relationship satisfaction and maternal bonding

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Details

Theoretical background: There is ample evidence for increased levels of parental perceived stress during times of crisis, such as the global COVID-19 pandemic. Caring relationships within the family during the first years of a child's life may not only serve as protective factors against heightened strain for parents, but the intrafamilial relationships may also not be independent from each other. The quality of the parental couple relationship might also influence the mother-to-infant bond and vice versa. The qualities of these intrafamilial relationships are also known to be crucial for the long-term development of children.

Thus, disentangling the complex relationship between perceived stress, couple relationship satisfaction, and bonding is of the utmost importance.

Research question: We aim to investigate the relationship between (1) maternal perceived stress, (2) couple relationship satisfaction, and (3) maternal bonding. We anticipate these constructs to be reciprocally related to each other.

Method: German mothers (*N* = 588) of index children, aged 0-3 years at the first time point, participated at two time points of the CoviFam online study, i.e. an ongoing longitudinal study designed to assess families' mental health during and after the COVID-19 pandemic. To date, measurements were taken at three time points (T1: May-November 2020; T2: February-March 2021; T3: February-May 2022). We administered the Perceived Stress Scale (PSS-10), the "Partnerschaftsfragebogen" (PFB-K), and the Postpartum Bonding Questionnaire (PBQ-16-R). The first part of our pre-registered analysis plan (see https://aspredicted.org/ix6s2.pdf) includes a cross-lagged panel analysis across the first two time points. The third time point now will allow us to apply an additional random-intercept cross-lagged panel analysis across all three time points.

Results: Initial analysis revealed significant associations between perceived stress, couple relationship satisfaction, and bonding, with absolute correlation values within time points ranging from r = [.21, 44] (p < .001). Regarding the cross-lagged effects across the first two time points, our analysis yielded a small, significant effect of maternal bonding at T1 on maternal perceived stress at T2 (β = -.10, p < .01). Additionally, the effect of couple relationship satisfaction at T1 on maternal bonding (β = -.06) and perceived stress (β = -.07) at T2 reached statistical significance (p < .05). Once data preparation of the third time point is completed, these effects will be investigated further and presented at the conference.

Discussion and conclusions: Our results highlight the protective role of intrafamilial relationships for maternal perceived stress during the first postpartum years in the context of a highly dynamic global crisis. In particular, the quality of the couple relationship and maternal bonding seem to play a crucial role when trying to shield mothers from increased levels of stress. Hence, a primary goal of psychosocial support should be to focus on strengthening intrafamilial relationships during the first years of life.

P2-H-395 - The mutual influences of prenatal mothers' and fathers' depressive symptoms on parent-infant synchrony after birth

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Details

BACKGROUND: Past research has shown that the presence of depressive symptoms during pregnancy is associated with parents being less engaged and having fewer positive interactions with infants after birth. The quality of parent-infant interactions in the first months of life is crucial for the development of the infant; indeed, enduring low-quality interactions during this period increases the likelihood of behavioral problems later in development. Previous findings are mainly derived from studies on mother-

infant relationships. Limited research has involved directly fathers and investigated how their prenatal depressive symptoms determine the quality of their interaction with the infant. There are mutual influences within the families, wherein perinatal symptoms of depression in both mothers and fathers can impact after birth not only the quality of their own interactions with the infant (actor effect) but also their partner's interaction quality (partner effects). To the best of our knowledge, no study has investigated the mutual influences between each parent's symptoms of depression during pregnancy and the quality of their early interactions with their infant.

AIMS and HYPOTHESIS: In this study, our focus was on the links between the parental reported prenatal symptoms of depression in both mothers and fathers and their own and partners' quality of interaction with their 3-month-old infant. We assessed the quality of interaction through parent-infant synchrony, an observational index referring to how the parent and the infant are in synchrony during their interactions. Our hypothesis posited that higher levels of depressive symptoms in mothers and fathers during pregnancy would adversely impact both their own and their partner's parent-infant synchrony after birth.

METHODS: Using the Actor-Partner Interdependence Model (APIM), we analyzed data from 86 families. Both parents assessed their depressive symptoms during the third trimester of pregnancy, and observations of parent-infant synchrony were conducted in a standardized laboratory situation (Lausanne Trilogue Play) three months after infant birth.

RESULTS: We found an actor effect only between mothers' depressive symptoms and mother-infant synchrony, whereas a partner effect was observed only between fathers' depressive symptoms and mother-infant synchrony.

CONCLUSIONS: The quality of the interaction between the mother and the 3-month-old infant was significantly influenced by both parents' depression during the third trimester of pregnancy, whereas the quality of interaction between the father and infant was not affected by how both partners reported their depressive symptoms. We will discuss how the early family organization in Switzerland could potentially explain the findings of this study. Additional insights into the interpretations and limitations of our study, as well as pathways for future investigations—especially those involving both parents—will be presented to enhance the understanding of mutual influences within families.

P2-H-396 - Differences in developmental patterns of cortical specialization in infants with a family history of autism: Testing the interactive specialization framework

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Details

Background

The Interactive Specialization model posits that cortical development is characterised by a progressive specialisation of neural responses to different categories of stimuli ('fine tuning'). This specialization manifests as a different topography of cortical response over development. Autism is proposed to be characterised by a different trajectory of cortical development, which may lead to different patterns of specialization, especially to social stimuli.

Objectives

To test evidence for progressive specialization for social stimuli in the first three years of life, in infants with and without a family history of autism.

Methods

Continuous EEG was collected from infants with no family history of neurodevelopmental conditions (FH-TD; n=59; 39% female), and infants with a family history of autism (FH-autism; n=100; 47% female) at 5, 10, 14, 24 and 36 months when viewing social and non-social videos (approximately 3 minutes total for each condition). Relative theta power (2 – 5 Hz) was estimated across four regions of interest (ROIs); frontal, parietal, temporal and posterior. A difference score (social – non-social) was calculated for each ROI at each timepoint and used as a marker of specialization for social stimuli.

To understand when changes in the topography of these difference scores, Longitudinal Item Factor Analysis (LIFA) models were used to test within-ROI differences in factor loadings between timepoints in the combined sample (see Figure 1a). To understand whether the FH-autism group had a different pattern of developmental change, Multiple Item Factor Analysis (MIFA) models were used to test group differences in factor loadings at each timepoint separately (see Figure 1b). Factor loadings for the difference scores indicate the degree to which different ROIs are contributing to the underlying latent construct of specialization. Robust standard errors were used to account for spatial clustering. Likelihood Ratio tests combined constrained (over time in LIFA models, between groups in MIFA models) vs. unconstrained models. When significant, Wald tests compared differences in each ROI to understand what was driving the pattern of effects.

Results

LIFA models showed a significant change in factor loadings between 5 – 10 and 24 – 36 months only (see Table 1). For the 5 – 10-month change, this was driven by an increase in loadings in the frontal, parietal and posterior ROIs. For the 24 – 36-month change, this was driven by a decrease in factor loadings in the frontal and posterior ROIs, and an increase in the parietal and temporal ROIs.

MIFA models showed significant group differences at 5, 10 and 36 months (see Table 2, Figure 2). At 5 months, the FH-autism group had a higher factor loading in the temporal ROI ($p < .001$). At 10 months, the FH-autism group had higher factor loadings in the frontal and parietal ROIs ($p = .023$, $p = .004$). At 36 months, the FH-autism group had a lower factor loading in the posterior ROI ($p = .003$).

Conclusions

Results suggest evidence for developmental change in the topography of response to social stimuli, such that frontal, parietal and posterior areas showed greater specialization between 5 and 10 months. Results also suggest a potential early delay in frontoparietal specialization in infants with a family history of autism.

P2-H-397 - Puppet versus human: Development of selective attention to speaking faces in the first year of life

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Details

Introduction: Attention to speaking faces associates with later social outcomes (Chawarska et al., 2013; Peltola et al., 2018). Toddlers with ASD show diminished attention to speaking faces (Chawarska et al., 2012; Shic et al., 2020); however, their attention to speaking puppet faces is comparable to that of typically developing (TD) controls (Macari et al., 2022). This suggests that toddlers with ASD may engage more readily with a puppet than a human speaker, opening up a new avenue for intervention. However, due to paucity of studies involving puppets versus humans as social agents, the normative developmental trajectories are poorly understood.

Objectives: To examine, for the first time, effects of the actor type (human, puppet), child-directed speech (speech, no-speech) and age (4, 6, 8, and 12 months) on attention to faces in infants with no family history (no-FHA) of autism in the first- or second-degree relatives.

Study population and Methods: Infants were tested longitudinally at 4 (M_{age}=4.19,*SD*=0.37; n=67), 6 (M_{age}=6.30,*SD*=.58; n=54), 8 (M_{age}=8.25,*SD*=0.39; n=49), and 12 months (M_{age}=12.4,*SD*=0.50; n=42) of age. Gaze behaviors were captured using a SR EyeLink 1000 Plus eye tracker. The Human condition depicted a woman situated in the center of the screen and looking directly at the camera; four distractor objects were present. The Puppet condition included a colorful, lifelike puppet operated by a professional puppeteer in an identical visual scene (**Figure 1A**). In each condition, two types of trials were presented: Speech: the actor looking at the camera and speaking using child-directed speech, and No-Speech: the actor looking at the camera silently. Each condition consisted of 16 8-second trials. Speech and No-speech trials were randomized within each condition. Percent looking time to actor's face (%Face) was calculated based on the time spent looking at the actor's face divided by the total amount of valid looking time.

Results: An actor (2) x speech (2) x age (4) linear mixed model on %Face indicated a significant actor x age interaction, F(3, 603)=2.73, p=.043). Attention to the puppet face was higher than to the human face at each age level, though the magnitude of the difference was the greatest at 4 months (**Figure 1B**). Attention to face was higher in speech than no-speech conditions, and the effect diminished with age

(**Figure 1C**). In all conditions there was a significant increase in attention to face between 4 and 6 months with no further significant increases at subsequent time points.

Conclusions: This work demonstrates that in no-FHA infants, attention to speaking faces undergoes a major developmental shift between 4 and 6 moths, regardless of the actor identity, and that a puppet face elicits greater attention than a human face at all age levels. Implications of this work are twofold: (1) deviations from normative developmental trajectories in attention to human and non-human social partners may inform about likelihood of developing social communication vulnerabilities in infants with FHA; (2) given their attentional salience in infancy, puppets may facilitate social engagement and development of language and communication skills in infants with FHA.

P2-H-398 - Growth trajectories of play and joint attention as predictors for language development in infants at elevated likelihood for autism

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Details

Background

Language abilities are highly heterogeneous in children with (elevated likelihood (EL) for) autism. Since language is a well-established predictor of long-term outcomes (i.e., quality of life, adaptive behaviour) in children with autism (Magiati et al., 2014), a better understanding of early language development is crucial. Several studies suggest an association between language and socio-communicative skills, such as joint attention (JA) and play (e.g., Frost et al., 2022; Kasari et al., 2012). Although language abilities are already heterogeneous at an early age, very few studies have investigated the association between JA/play and language in infants with EL for autism. Moreover, developmental trajectories of these socio-communicative skills are rarely studied in relation to language (Hebert et al., 2004; Malesa et al., 2013). Both prematurely born children (preterms) and siblings (of children with autism) are well-known EL-groups for autism.

Objectives

The current prospective longitudinal study investigated the predictive value of initial level (10 months) and growth rate (10-24 months) of play, initiating JA and response to JA for expressive and receptive language abilities of 24-month-old children with EL for autism.

Methods

Siblings (*n*=48) and preterms (born before 30 gestational weeks, *n*=49) were assessed at 10, 14 and 24 months. Videos of the Communication and Symbolic Behavior Scale Developmental Profile (CSBS-DP) were coded for quality and frequency of (pre-)symbolic and constructive play behaviour. Videos of the Early Social Communication Scales (ESCS) were coded for IJA and RJA behaviours. Expressive and receptive language abilities were assessed with the Bayley Scales of Infant Development (BSID-III).

Results

Separate models were analysed for expressive and receptive language with intercept or slope of play, IJA, RJA, group, and their interaction as predictor variables. Analyses were conducted on 50 imputed datasets, and results were pooled together afterwards. A positive association was found between initial level of play and expressive language in siblings (estimate = .75, p = .009), but not in preterms (estimate = -.01, p = .02). Initial levels of IJA (p = .81; p = .67) and RJA (p = .11; p = .31) of siblings and preterms were not related to receptive and expressive language, respectively. Also, the growth rates of play (p = .57; p = .71), IJA (p = .63; p = .85) and RJA (p = .73; p = .83) were not related to language abilities in both groups.

Conclusion

Our results highlight the relevance of play as measured by the CSBS-DP in children at EL for autism, before their first birthday. Further, the role of play in early development may be different for preterms relative to siblings, and for expressive relative to receptive language. Contrary to our expectations, we did not find any such associations for IJA and RJA. Given the presence of associations in studies with older children (with autism), future research should investigate whether and/or when these appear in EL-groups. As the investigated associations were rather limited, our results suggest examining other predictors in relation to early language development, especially in children with atypically developing language.

P2-H-399 - Mommy, actress, or synthesizer? The influence of social cues on voice cortical tracking in 18-month-olds

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Details

In the early months of life, social cues serve as the primary means through which infants interact with the surrounding environment. One of the most important social cues in the environment is the human voice. The ability to process and distinguish the human voice emerges early in development (Davies-Thompson et al., 2019), enabling preverbal infants to actively engage with and learn from their surroundings. To date, the majority of studies have extensively focused on speech processing, and far less is known about general voice processing and how it develops (Grossmann et al., 2005). We here attempt to shed light on the impact of social cues in voice processing in infancy using cortical tracking of external stimuli, a method based on the idea that the brain rapidly responds to environmental stimuli by tuning oscillations facilitating communication between distant brain regions (van der Velde et al., 2021). To unravel the impact of social cues on influencing auditory processing, we manipulate the social significance of stimuli by exposing 18-month-old infants to the same nursery rhyme narrated by either a synthesizer, an actress, or the infant's mother. We collected data from 26 infants (12 females, Mage = 18.8 months, SDage = 1.09). Each nursery rhyme was presented three times to infants while showing on a screen the same engaging neutral video (i.e., a flying rocket) to maintain the infants' attention. Cortical tracking of the nursery rhyme was assessed by voice-brain coherence, which measures the consistency

of phase differences between two signals and the synchronization between neural oscillations and the acoustic envelope at any given frequency. The higher the coherence between brain activity and the acoustic envelope, the better the tracking of incoming auditory information.
As the mother's voice represents one of the earliest and most significant sounds in infants' environments—perceptible even in the womb (Abrams et al., 2013)—we expected that it would exert facilitative effects on supporting socio-auditory processing. Specifically, we hypothesized that infants would benefit from the presence of prosodic information in their mother's voice, and secondly to the actress's voice, may take the form of higher coherence values in response to these stimuli.
To date, preliminary results suggest higher coherence in response to the actress's voice compared to the synthesizer (p = 0.004). However, contrary to our initial hypothesis, we do not observe results in response to the mother's voice in infants (all ps > .08). Still, these preliminary findings highlight the role that prosody plays in voice processing, reflecting a possible mechanism of novelty processing of voices infants are less exposed to. Nevertheless, these results should be interpreted with caution, as our full sample is still being analyzed. Overall, these results suggest a tracking of auditory stimuli in 18-month-old infants guided by social cues where both the prosodic information and stimulus characteristics (i.e., novelty of the actress's voice) interact and play a crucial role in voice processing. Moreover, this study provides evidence of the usefulness of neural tracking analysis in samples characterized by reduced data quality, such as infants.

P2-H-400 - Communicative functions of infant everyday word production

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Details

Language is inherently social, and a key aspect of children's language development involves understanding the communicative functions of words. Much work on infant word production focuses on the "class" of words, and shows that nouns dominate the vocabularies of English-speaking infants. Such findings may lead to the assumption that infants' early word use mainly serves the function to label objects. However, a focus on word class and object naming ignores the variety of ways that infants may use words—that is, the pragmatics of language use. Indeed, infants may use words to describe people, express emotions, or request actions. We sought to document the range of communicative functions that 1-to-2-year-old infants convey in their use of words during everyday activities in the home environment in a socio-linguistically diverse sample.

Researchers video-recorded 60 mothers and their 13-to-26-month-old infants (Latine, N=30; European-American, N=30) at home during everyday activities for 103 minutes on average (SD=17.42). Mother and infant language was transcribed word by word in English and/or Spanish to identify meaningful units of speech (i.e., utterances for mothers, and non-distress vocalizations for infants). Infant vocalizations were considered a "word" if it phonetically approximated a conventional word form (e.g., baba for bottle; uh-oh; wow). Grunts, burps, vegetative sounds, babbles, and cries were not coded as words. Infant words were coded for their communicative function (Table 1), and further marked as produced spontaneously or in imitation to a mothers' preceding utterance.

Preliminary results show that infants produced many vocalizations during the visit (*M* = 1027, *SD* = 237, *Range* = 722-1279). On average, 29% of vocalizations fit the definition of a "word". By this definition, infants averaged 282 words (*Mdn* = 290, *SD* = 148, *Range* = 121-501) and on average produced 70.5 words per 30 minutes (*Mdn* = 72.5, *SD* = 36.89, *Range* = 30-125). On average, 13% of infant words were imitations of their mothers' previous utterances (*M* = 35, *Mdn* = 36, *SD* = 35, *Range* = 5-69).

Infants varied in their repertoire of communicative functions. Notably, although infants frequently used words to *label/describe* (i.e., 27% of words)—with over 17 percent of their words serving to *label/describe objects*, the majority of words (73%) did not follow the traditional and assumed function of labelling. Infants most often used words as *requests* (i.e., 38% of words). With *request* words (e.g., "this", "mama"), infants would most often ask for objects (10% of words), attention (9% of words), or actors (9% of words). They also used words to make *exclamations* (29%), with top *exclamation* words (e.g., "no", "uh-oh", "wow") most often expressing *objection* (13% of words), *mistakes* (7% of words), or *emotion* (6% of words). Although preliminary data report on English-speaking infants, the developed coding manual on infant pragmatics generalized to infants in Spanish-speaking homes.

Most centrally, our work reveals unprecedented data on how infants use language—that is, the functional use of words—moving beyond counts of word types or tokens that dominates the field. Ongoing analyses will compare the variety of communicative functions displayed by infants from English- and Spanish-speaking homes.

P2-H-401 - Kinship terms of address and reference among families in Singapore

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Details

Knowing how to name people appropriately lies at the intersection of social cognition and language development. While names for parents tend to be some of the earliest words acquired by infants (cf. Wordbank), languages differ in the conceptual structures encoded in kinship terminology, as well as practices for naming and address. Many East and Southeast Asian languages refer to family members by their detailed position in the family hierarchy. For example, Mandarin kinship terms for children specify the generation and gender, but also relative birth order (e.g., 大姐 *da4jie3* 'big older sister', 二姐 *er4jie3* 'second older sister', 妹妹 *mei4mei4* 'younger sister'). It remains an open question how multilingual communities socialise their children into naming customs that are deemed culturally appropriate. In Singapore, English is the main language of business and education, and 86.8% of people report speaking English alongside one or more of the other official languages at home (Mandarin Chinese, Malay and Tamil; Department of Statistics, 2020). English kinship systems in countries of the Inner Circle tend to use given names in many contexts, while the other languages do not.
Methods: 76 parents of children under the age of 4 years were recruited for an online survey with audio recording questions delivered via Phonic.ai. Parents were asked to say aloud how they name their child when they address them directly, and for each family member they saw frequently (at least once a month), they were asked to name the family member to the child, and to name their child to the family member (Figure 1). To date, responses of 40 parents have been transcribed and coded for the name

used in different scenarios (address dyads: *n* = 40; naming triads: *n* = 82), resulting in 122 naming events. To clarify the preference for given names versus kinship terms, affectionate nicknames were excluded from the primary analysis (24%).
Results: When addressing their child in any language, most parents use the child's given name (64%), rather than a relational kinship term (e.g., baby, *adik* 'younger sibling' in Malay, *弟弟 di4di0* 'younger brother' in Mandarin). However these ratios differ when talking to siblings: When talking about the same child to an older sibling, a parent is equally likely to use the child's given name (46%) or a relational term (54%), but when talking to a younger sibling the parent is much more likely to use a relational term (89%). Similarly, in a naming triad with grandparents, parents are more likely to refer to their child by their given name (64%), and to refer to the grandparents by a relational term (100%). These findings suggest that early socialisation encodes the importance of relational names when taking about people who are older, but not younger.
The full paper will present data broken down by language for the full data set (*N* = 76, triads = 204), and offer a sociolinguistic discussion of the convergence and divergence in the use of kinship terms in multilingual multicultural Singapore.

P2-H-402 - Associations between socioeconomic stress, engagement in joint attention, and infant neurodevelopment in 24- to 36-month-old infants

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Details

Explorations of joint attention (JA) have highlighted how the quantity and quality of interactions between infants and their caregivers shape infant neurodevelopment and scaffold essential socioemotional skills (e.g., language, socioemotional cognition) (Koşkulu et al., 2021; Mundy & Jarrold, 2010). The number of JA interactions between infants and their caregivers, and the quality of these interactions, have been positively associated with many features of language development across childhood (Betancourt et al., 2015). In contrast, experiencing low-SES and high stress has been negatively associated with language outcomes from infancy (Betancourt et al., 2015; Brandes-Aitken et al., 2020). Language disparities might emerge because of disrupted JA engagement early in life, however research on associations between SES and JA, especially neural mechanisms underlying JA, is limited (Brito et al., 2016; Tomalski et al., 2013). It is unknown whether early life stress might disrupt early neurodevelopment via reductions in the quantity or quality of JA interactions. The current study explores associations between caregiver socioeconomic stress (SE-stress) at 6 months, dimensions of engagement in JA at 24 months, and baseline neural activity in 24- to 36-month-old infants. Caregiver-infant interactions during free play, self-reported caregiver SE-stress and 2-5 minutes of infant baseline electroencephalography (EEG) were obtained from 116 mother-infant dyads enrolled at 2 months from pediatric primary care clinics predominantly serving families from low-income backgrounds. Free-play videos were coded for dimensions of JA, including duration and frequency of JA episodes, type of initiation (mother directs vs mother follows), type of termination (by infant vs mother) and type of JA (coordinated vs passive). Subscales for quantity and quality of JA were created from these dimensions. Theta and alpha power and frontal-central-parietal alpha functional connectivity were extracted from baseline EEG, as these features have been positively associated with engagement in JA (Brito et al, 2016;

Gartstein et al., 2021; Mundy & Jarrold, 2010). Multiple regression will be used to test associations between SE-Stress, quantity and quality of JA engagement, and infant baseline EEG. We predict higher caregiver SE-stress at 6 months will be associated with a) less and lower quality engagement in JA at 24 months, b) lower EEG power in theta and alpha frequency bands, and c) lower alpha functional connectivity during baseline at 24 and 36 months. We further predict that lower quantity and quality JA will mediate associations between caregiver SE-stress and infant baseline EEG (theta and alpha power; frontal-central-parietal functional connectivity). Finally, a moderation analysis will test whetherthe quality and quantity of engagement in JA during play can buffer against negative effects of SE-stress on infant neural mechanisms underlying JA. Specifically, we test whether negative associations between SE-stress and child EEG are reduced for dyads in which high-quality JA engagement is observed. Investigating how foundational neural processes developed and strengthened via JA might be disrupted by low-SES can reveal how language disparities emerge over time, and suggests avenues to support families under these circumstances. This analysis plan has been pre-registered using the Open Science Framework (https://doi.org/10.17605/OSF.IO/5AJVG). Ongoing analyses will be complete by April 2024.

P2-H-403 - How attention guidance shapes infants' visual cortical processing of objects vs background

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Details

In the first year of life, infants show a significant development in their ability to selectively attend to objects in the environment, with crucial consequences for early cognitive functioning and learning (Reynolds, 2015). Social interactions influence infants' attention: When looking at novel objects, infants' neural responses increase following joint attention and eye contact with an adult (Hoehl et al., 2014). However, it is not yet established whether early social interactions can shape infants' visual processing toward the object versus background of a visual scene (Bornstein et al.,2011). Here we conducted an experimental study to test if differential attention guidance can shape infants' visual cortical processing of object versus background of a visual scene. Visual processing of object versus background could be assessed in children's electroencephalogram by using frequency tagging (Köster et al., 2017, 2023). This is, presenting object and background at different driving frequencies elicits separate evoked responses for each element. In the current electroencephalography (EEG) study, 11-12-month-old infants (n = 53) watched natural images with an object in front of a background, flickered at different driving frequencies (5.67 and 8.5 Hz, counterbalanced) while infants' visual cortical processing was recorded with EEG. We applied a between-group, pre-post design with an experimental manipulation (training phase). During training, an experimenter guided infants' attention by consistently pointing either to the object or the background on the scene (according to group). Our preliminary results showed that infants' neural responses increased at the stimulation frequencies at occipital electrode sites, supporting the utility of frequency tagging as a tool to assess infants' visual cortical processing during social interactions. We will present further results on how differential attention guidance shapes infants' visual attention to objects vs background. Our study will help to uncover the role of early interactions in the development of attention allocation and scene perception.

P2-H-404 - Are faces really infrequent in the view of toddlers at home, and how infrequent are they in the caregiver view?

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Details

Social stimuli, especially faces and bodies, are an important feature of the toddler visual environment, and the ability to extract information from these stimuli (e.g., identity and affect) is necessary for social functioning. While seemingly simple, these skills have protracted developmental courses. Information available in the environment may be crucial in allowing these skills to emerge. Previous research has suggested a decline in faces (but not bodies) in the visual field from birth to toddlerhood. However, the research that exists is limited and has its limitations. There is no clear evidence as to whether any decline in face frequency is a temporary, unique feature of toddlerhood or whether this is reflected in the caregiver view, which would be informative in understanding whether it is the frequency of faces for infants or the infrequency of faces for toddlers that is unique. To address these gaps, we set out to quantify and compare visual input of socioemotional stimuli (faces and bodies) in the egocentric views of toddlers and their caregivers. We instructed 26 toddler-caregiver dyads (N = 26, with 24 recording from the caregiver perspective; M age = 29.26 months) in Northern England to record at home using egocentric head-mounted cameras, for one hour a day for one week. We hypothesized that: 1) The frequency of faces in the infant view would be lower than the frequency of bodies in the infant view; 2) The frequency of faces would not be as low as previously suggested; 3) Face frequency in the caregiver view would be lower than body frequency in the caregiver view; 4) Face frequency in the caregiver view would be comparable to that in the toddler view. Results suggest that the relative frequency of faces present in the visual field of toddlers is low in comparison to that of bodies. On average across participants, from the toddler perspective, 12.56% of frames (SD = 5.52) contained faces while 54.75% of frames (SD = 6.71) contained bodies. Further, faces are more frequent in the caregiver view than the toddler. On average across participants, 24.05% (SD = 9.42) of caregiver-perspective frames contained faces, and 72.95% (SD = 9.09) of frames contained bodies. A two-way repeated measures ANOVA (perspective x stimulus) revealed a statistically significant interaction between perspective and stimulus type ($F(1, 23) = 13.362$, $p = .001$). This would suggest that faces truly are less frequent stimuli in the view of toddler, and that this is unique to toddlers, with adult caregivers in the same environments seeing faces much more frequently. However, it also suggests that there is a wide degree of individual variation in the frequency with which faces are seen. Future research should examine factors shaping this variability, as well as how this variability relates to subsequent socioemotional development, in order to fully understand its significance.

P2-H-405 - Teaching bodily attention: The interplay between infant self-touch and caregiver (affectionate) touch

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Details

Touch is believed to play a key role in developing an infant's body representation (Bremner & Spence, 2017). Infants can collect tactile information through self-touch (Fagard et al., 2018) and also receive a significant amount of tactile information from caregivers who touch them over 60% of the time (Jean et al., 2009). There is limited research exploring the longitudinal development of maternal and infant self-touch, particularly in relation to each other (Ferber et al. 2008; Jean et al., 2009). In particular, maternal touch was found to direct infant attention to the mother's hands in the study by Stack and Muir (1990). In the same vein, caregiver touch might attract the infant's attention to the own body, increasing the likelihood of the infant touching themselves. Similar concepts of attention socialization have been presented by Zukow-Goldring and Arbib (2007) in the action domain. This study examined the touching behavior of 118 mother-infant pairs at 5-months (T1) and 9-months (T2). During a 5-minute free-play session without toys, we recorded the mother's type of touch and the infant's touch location every 2 seconds. We measured the duration of touch in three categories: general maternal touch, maternal affectionate touch, and infant self-touch. Over time, all types of touch decreased from T1 to T2 (see Table 1), and relative duration at T2 was predicted by relative duration at T1 in cross-lagged panel models (see Figure 1). At T1, infant self-touch correlated with the amount of maternal general and affectionate touch; however, we did not find any cross-correlations. Most importantly, analyzing the sequential data from each participant at T1, we demonstrated that maternal affectionate touch was a significant predictor of self-touch in the subsequent 2-second interval. A general binomial mixed model was utilized, with general maternal touch and maternal affectionate touch being considered as fixed effects, and participant as random effect. The model revealed that maternal affectionate touch increased the odds for infant self-touch by 1.24 (p = .002). Infant self-touch increased the chances of receiving maternal affectionate touch in the next interval (Odds = 1.37, p < .001), but not for maternal general touch (Odds = 0.96, p = .41). Thus, at T1 there existed a mutual relation between maternal affectionate and infant self-touch. At T2, maternal touch did not predict infant self-touch in the next interval, while infant self-touch decreased the probability of receiving maternal general touch (Odds = 0.81, p < .001). Taken together, previous findings have been replicated indicating a decrease in both maternal and infant self-touch over time. Notably, a sequential analysis demonstrated that maternal affectionate touch had a positive effect on drawing the attention of 5-month-old infants to their own body, thus increasing the likelihood of maternal affectionate touch. Consequently, there appears to be a reciprocal process of touch socialization, with emphasis on the context within which infants develop (see Tamis-LeMonda & Masek, 2023, for a similar claim).

P2-H-406 - From understanding to action: the role of the socio-cultural learning environment in this key prosocial transition

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Details

From around 10 months of age, infants exhibit an intrinsic understanding of others' needs (Koester et al., 2016). However, this apparent prosocial understanding only predicts future helping behaviour when

motor and social interaction skills are considered (Koester et al., 2019). This suggests that the ontogeny of helping behaviour relies on a complex interplay of developmental processes.

Uganda provides an interesting backdrop from which to study the emergence of prosocial behaviour in infancy. Compared to infants in Western settings, there is evidence that the learning environments of infants in a proto-typical Ugandan setting may allow for the earlier onset of motor skills (Holden et al., 2022). Furthermore, socio-cultural trends of distributed caregiving may also provide infants with more opportunities to improve their socio/cognitive abilities. Thus, the emergence of prosocial behaviour in infants in Uganda may differ in its trajectory from those from a typically-sampled Western setting. Nevertheless, with the rapid influence of westernisation and urbanisation across Africa, it is also important to consider how within-country variation in learning environments might also shape how prosocial development emerges.

The present study addressed this by longitudinally sampling a large cohort of infants in rural and urban Uganda (approx. N = 250) along with a comparison group in the UK (N= 50). At 10 months, infants engaged in an eye tracking study to establish infant need understanding. Infants' gaze was monitored in response to seeing an animated character in need of help, unable to achieve their goal, versus a second character that was not in need. After introducing a third agent who could offer help to either character, it was predicted that if infants understand other's needs, they should look longer (in surprise) towards scenes where the character, who does not need help receives help.

At 16 months, the same infants participated in a classic out-of-reach helping task validated for use in cross-cultural settings (Warneken & Tomasello, 2007), as well as tasks to establish their motor and social interaction skills (Fernandes et al., 2020; Mundy, 2003).

Infants at all sites were able to distinguish a character in need from a non-needy character. Furthermore, using a beta regression model the results showed that this ability at 10 months predicted their helping behaviour at 16 months, but only when motor and social skills were included in the model. Across sites, no interaction was found between needs understanding and social and motor skills as had been predicted. These results support the theory that regardless of the cultural context in which an infant grows up, humans may have a biologically rooted prosocial tendency that is present in the first year of life. However, the ontogeny of helping behaviour also relies on additional factors such as social and motor skills.

P2-H-408 - Longitudinal associations between implicit perspective-taking and prosocial behaviour in toddlerhood

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Details

Toddlers perform various prosocial actions, such as retrieving objects and providing comfort (Warneken & Tomasello, 2007; Dunfield, 2010). But what socio-cognitive abilities facilitate their spontaneous prosociality? Past work suggests that Theory of Mind (ToM) promotes children's helpfulness (Imuta et

al., 2016), specifically that cognitive ToM (mentalizing about others' knowledge/desires) relates to instrumental helping, while affective ToM (mentalizing about others' feelings) associates with empathic helping (e.g. comforting; Carlo et al., 1991). However, most previous studies have used *explicit* ToM measures (e.g., Wellman & Liu, 2004) with school-aged children, well after the onset of spontaneous prosociality. Nonverbal paradigms (e.g., Vaish et al., 2009; Scott et al., 2012) allow researchers to detect earlier, *implicit* forms of perspective-taking; however, it remains unclear whether implicit ToM performance also relates to toddlers' emerging prosociality. We addressed this gap by examining associations between 24- and 30-month-olds' implicit ToM (both affective and cognitive) and prosociality at 30 months.

Data was drawn from a longitudinal study (target n ~500) exploring sociomoral development across infancy. At Time 1 (T1; M_{Age}= 24 months) toddlers completed an affective ToM measure (Vaish et al., 2009). They watched four live-action plays where one actor was harmed by another (e.g. destroyed their drawing), but the victim did not demonstrate overt emotional responses to the harmer's actions. Longer sum duration of looks toward the victim during each 15 second period following harm indicates greater affective ToM. At Time 2 (T2; M_{Age}= 30 months), toddlers participated in a cognitive ToM measure (Scott et al., 2012) during which a researcher read an illustrated story about a character with a false belief about a toy's location. When asked where the protagonist would look for the toy, longer looking to a belief-consistent (versus reality-consistent) image demonstrates greater implicit cognitive ToM. At T2, toddlers were also given opportunities to help clean up toys (instrumental helping; scored 0 - 3; Bryan et al., 2014), respond to an experimenter feigning injury (comfort; scored 0 - 4; Zahn-Waxler et al., 1992) and react after "breaking" a toy that is designed to fall apart (guilt; scored 0 - 7; Kochanska et al., 2002).

Linear regression analyses using preliminary data (n = 39; 41% female) indicates that affective ToM at T1 explains 25.08% of the variance in instrumental helping scores at T2 (p = .001) but does not predict other prosociality variables (Table 1). Toddlers' implicit cognitive ToM scores at T2 are not associated with any of their prosociality scores (Table 1). At T2, comforting and instrumental helping scores are positively, moderately associated (r = .36, p = .02; Table 2).

These preliminary findings suggest that implicit *affective* ToM might promote specific prosocial behaviours in toddlerhood. In contrast to previous work with *explicit* cognitive ToM measures (Imuta et al., 2016), individual differences in toddlers' *implicit* cognitive ToM does not appear to associate with toddlers' prosocial actions or emotions. Perhaps at younger ages, orientation to others' emotional states as opposed to their knowledge/belief states, is more important for particular prosocial responses. That said, planned analyses with the full sample size will allow for more conclusive inferences to be drawn.

P2-H-409 - Toddlers' helping behavior is affected by the effortful costs associated with helping others

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Details

Although the presence of early instrumental helping behavior has been firmly established (e.g., Liszkowski et al., 2006; Warneken & Tomasello, 2007), debate remains regarding whether early helping

behavior is altruistically motivated or not (e.g., Kenward & Gredeback, 2013; Paulus, 2014), and whether and how children's motivation to help others changes with age (Brownell et al., 2006; Grueneisen & Warneken, 2022, Svetlova et al., 2010). Given that a willingness to sacrifice one's own time and energy to assist others is a defining feature of altruism, one way to adjudicate the issue is to examine whether the costs associated with helping affect children's helping behavior, and if this effect varies with age. Here, we investigate whether a range of effort-related costs influence children's helping across infancy to early childhood.

Canadian 20- to 36-month-olds (n = 48, M = 27.60 months; 22 females, 26 males; 20% White) participated in four different helping tasks varying in the type of effort required to help (lifting force, cognitive load, steps required, and pushing force). Across two between-subjects conditions, toddlers were randomly assigned to perform either high-cost or low-cost helping. This design allowed us to precisely quantify the effects of objective costs (e.g., objective differences in required force) as well as subjective costs, by measuring individual toddler's skills performing the target actions.

Indeed, toddler's helping was uniquely influenced by multiple costs. When helping was more objectively costly, children were less likely to help correctly, $t(49) = -2.21$, $p = .03$, took longer to help, $t(49) = 2.27$, $p = .03$, and required more prompts, $t(49) = 2.55$, $p = .01$. These patterns were simultaneously mirrored in subjective costs, such that children who were less skilled at performing the target actions also were less likely to help correctly, $t(178) = -4.11$, $p < .005$, required more experimenter prompts, $t(174) = 3.22$, $p = .002$, and had longer test trials, $t(176) = -3.48$, $p < .001$. Importantly, we did not find evidence of task differences, $p \geq .18$, suggesting that children's actions were sensitive to multiple kinds of effortful costs. Likewise, while children were more likely to help with increasing age, these increases in helping were more parsimoniously explained by the decreasing subjective costs (as indexed by their skill performing the target actions) associated with increasing motor ability, rather than age-related differences, all $ps \geq .08$, in motivation to help others.

Taken together, these findings suggest that early helping is calibrated to the objective and subjective costs associated with helping. Young children's willingness to help and quality of helping were influenced by a simultaneous consideration of both objective and subjective costs across a variety of effort-related costs. Our work also suggests continuity in children's underlying motivations for helping across the developmental window from the first onset of helping in infancy to its flourishing in early childhood, rather than a shift towards or away from altruistic motivation.

P2-H-410 - As seen on TV: Maternal depression and home CHAOS predict infant media exposure

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Details

The American Association of Pediatrics recommends no screentime for infants under 18 months, except if video chatting with a family member due to COVID-19 restrictions (Pappas, 2020); however, there are many infant-specific media channels available at any time of the day and infants under two years old are estimated to spend 30-40% of their time awake watching TV (Christakis, 2009). The latter study proposes two theoretical mechanisms to explain why screentime exposure may be deleterious to infants. First, screen content may overstimulate the undeveloped brain and, second, it may impede engagement in more appropriate activities like playing with toys or books. The latter is especially important, as the act of parents reading to 8-month-old infants is linked to improved language skills at 12 and 16 months (Karrass & Braungart-Rieker, 2005), and interacting with both reading and a caregiver improves word comprehension and sustained attention (Vally et al., 2014). There are a number of environmental aspects that can influence the amount of TV and book exposure children experience, some of the most important being those associated with family dynamics, such as maternal depression and household chaos. In fact, the literature suggests maternal depression is a primary predictor of screentime use in preschool-aged children (Park et al., 2018), however, less is known about household chaos. There is also a dearth of literature on these effects in younger infants. Thus, the present investigation aims to answer the question: Do family dynamics when infants are 3.5 months old, specifically maternal depression and household chaos, predict infant media exposure at 5 months (TV and books), while controlling for maternal depression at 5 months, infant media exposure at 3.5 months, and sociodemographic risk (race, subjective social status, family income, and maternal education)? It is hypothesized that both increased maternal depression and household chaos when infants are 3.5 months old will significantly predict increased TV exposure and decreased book exposure at 5 months old. Data from 54 infants will be included in the final analysis. The data have been collected but are in the process of being cleaned. Figure 1 shows the frequency and variability of TV watching in this sample. Preliminary analyses with a small subset of the data (n = 10) revealed that heightened TV watching per week at 5 months of age is significantly correlated with both chaos at 3 months of age, $r(8) = .64$, $p = .045$, and maternal depression at 3 months of age, $r(8) = .83$, $p = .003$. This is consistent with the aforementioned hypothesis, suggesting maternal depression and household chaos at 3 months significantly predict the amount of TV watched by infants at 5 months old; however, these analyses should be interpreted with caution until the complete data set, including relevant covariates, is analyzed. If these results continue as hypothesized, they would suggest that research on media exposure, even in infants as young as 3 months, should consider family dynamics, especially those associated with maternal depression and the amount of chaos in the home.

P2-H-411 - Paternal experience as described by primary and non-primary caregiving Brazilian fathers in the infants' fifth month

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Details

The father's involvement in direct activities with the child, such as play and basic care, is more frequently associated with developmental outcomes when compared to the engagement in indirect activities, such as attending medical appointments or providing resources. Basic care activities such as bathing and feeding allow the father to develop skills to respond to the infant's signals sensitively and gradually experience fewer afflictive feelings when faced with the infant's distress. This study described

paternal involvement from the perspective of Brazilian fathers who exercised three different levels of caregiving in the infants' fifth month: *primary caregiving* (basic care addressing the infant's physical and emotional needs), *secondary caregiving* (assistance to the partner or a second caregiver in direct care when necessary), *and financial provision* (indirect care of the family's material provision). Participants were ten first-time fathers who self-reported childcare and other activities performed with the infant in a questionnaire (via Google Forms) and answered a 50-minute semistructured interview (via videoconference). The questionnaire results allowed us to classify the ten participants into the three levels of caregiving. The results from the interviews' thematic analysis showed differences in how the primary, secondary, and provider caregivers dealt with three fundamental themes of fatherhood. The first theme, fathers' time, revealed that secondary and provider caregivers perceived lack of time as a strong reason for little involvement in basic childcare. In contrast, the boundaries between time for work and time for the baby were less demarcated for primary caregivers. The second theme, fathers' interaction, indicated that all fathers reported advances in their children's motor development affecting interactions. However, only primary caregivers reported cognitive advances and their repercussions on interaction with their infants. The third theme, fathers' lap, demonstrated remarkable difficulties faced by secondary and provider caregivers to comfort the infants when they were distressed and to put them to sleep, which caused anguish, especially for provider caregivers. In summary, these results indicate that primary caregiving may establish essential foundations for parenting skill development, such as time availability and accurate perception of infants' development, which, in turn, may contribute to increasing sensitivity during interactions and, consequently, improving infant development. Future research on paternal involvement must estimate the weight or preponderance of different types of activities (e.g., basic childcare vs. play) in predicting developmental outcomes. This knowledge may favor early child development and reduce gender inequalities in hetero-affective families.

P2-H-412 - An experimental test of the effects of acute and chronic stress on maternal sensitivity

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Details

Introduction: Maternal sensitivity is integral to healthy child development (Leerkes, Blankson, & O'Brien, 2009; van den Boom, 1994); therefore, it is advantageous to identify its predictors and correlates. Caregiver sensitivity may be hampered by concurrent life stress (Belsky & Fearon, 2002). Indeed, most studies find associations between maternal sensitivity and various aspects of stress, such as family stress (e.g., financial strain, job loss, illness, and death; (Belsky & Fearon, 2002). Yet these studies do not reveal whether maternal stress causes maternal insensitivity. In this study, we used experimental manipulations of stress to evaluate whether maternal stress could lead to maternal insensitivity, furthering our understanding of how stress may impair maternal sensitivity and on which mothers' stress exposure may have more of an impact.

Method: One hundred sixty-two women took part in this study during their third trimester of pregnancy, where chronic stress was assessed via the UCLA Life Stress Interview. When their infants were 7 months old, mothers attended a lab visit, where they were randomly assigned to a "worry" group (an acute stress exposure writing task) or a control group (a neutral writing task). (For writing task prompts, see

Appendix A.) Mothers then completed the Still-Face Paradigm with their infant, during which maternal sensitivity was assessed.

Results: We tested firstly whether mothers who were exposed to a parenting-related stressor would demonstrate lower levels of maternal sensitivity following this stressor, and secondly, whether higher maternal chronic stress levels in the past would interact with the worry condition to predict lower maternal sensitivity. First, using regression, we found no significant main effects of the stress condition on maternal sensitivity (B = -.01, p = .64). Secondly, using a hierarchal regression to test for moderation, we found a significant main effect of chronic stress (B = -.093, p = .005) and a significant interaction between the acute stress condition and chronic stress (B = -.18, p = .024), on maternal sensitivity. Simple slopes revealed that this interaction was only significant for women who had a history of high chronic stress (B = -.09, t = -1.97, p = .05; see Figure 1). For these women, being exposed to an acute stressor before completing the still-face paradigm with their infant predicted lower maternal sensitivity than women who had a history of lower chronic stress or women who were not exposed to the acute stressor.

Discussion: Maternal stress may influence the sensitivity that she can show toward her child. To our knowledge, no study has involved an experimental manipulation of a parenting-related acute stressor immediately before the interaction in which maternal sensitivity was assessed. Using a rich stress measurement interview and a novel experimental design, our study aimed to address these issues. Our results showed that a mother's history of chronic stress seemed to influence her future ability to manage acute stress and nurture her infant. These results can help us identify specific parenting factors that are amenable to intervention.

P2-H-413 - Maternal psychological availability for her infant: Associations with work-related negative mood, psychological exhaustion, and recovery

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Details

For mothers to be able to respond to their infant's emotions and behaviours in timely and appropriate manner, being psychologically available is a prerequisite. As many mothers worldwide return to work within the first few months postpartum, being psychologically available might depend on their work-related experiences. Whereas positive aspects of combining motherhood with employment have been observed, ample research showed evidence for negative spillover from work into family. Specifically, the effort needed to perform work tasks and potentially stressful work situations, may cause increased levels of negative mood and lack of energy after work, which may inhibit the psychological availability of mothers for their infant. Importantly, this negative spillover from work into family may be reduced or even avoided when one has the opportunity to recover from strains originating from work.

In the current pre-registered study, we first examined whether higher levels of maternal work-related negative mood and psychological exhaustion are associated with less maternal psychological availability for the infant in the evening, and whether these negative associations are weaker as mothers report higher levels of pleasure experienced during the after-work activities. Furthermore, as negative mood and psychological exhaustion might persist until the next morning, work-related negative mood and psychological exhaustion may also be related to maternal psychological availability the next day, especially when no recovery takes place. As such, we subsequently addressed whether higher levels of maternal work-related negative mood and psychological exhaustion are associated with less maternal psychological availability for the infant during the next day, and whether these negative associations are weaker as mothers report higher levels of pleasure experienced during the after-work activities and sleep quality during the preceding night.

Participants were 138 healthy working mothers with a healthy infant under six months, who recently returned to work after their maternity leave. The questionnaire data was collected on two consecutive study days: a workday and a non-workday spent with the infant. Analyses showed that work-related negative mood, but not psychological exhaustion, was associated with lower psychological availability in the evening. However, this result appeared not robust across all analyses and follow-up examinations. Furthermore, while experiencing pleasure during the after-work activities and sleep quality were not found to play a moderating role, experiencing pleasure was associated with higher psychological availability in the evening and during the next day. This study highlights the potential importance of recovery after work by experiencing pleasure during after-work activities for maternal psychological availability for the infant.

P2-H-414 - Toddlers' physiological and behavioral response to parent's mobile device distraction and technoference

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Details

Given the prevalence of mobile device use the current study examines the impact of parents' mobile device distraction (*technoference*) on toddlers' physiological and emotional functioning (e.g., Stockdale et al., 2023). We suspected that toddlers' would demonstrate difficultly maintaining physiological and emotional homeostasis when parents became distracted by their mobile device. In this study, we examined toddlers' (N = 129, M age = 29.05 months) physiological and behavioral responses across three conditions in an induced technoference task that mimicked elements of a traditional still face paradigm (i.e., social engagement, phone distraction, and social recovery). Like previous studies employing the still face paradigm (e.g., Tronick & Beeghly, 2011), most toddlers demonstrated a loss of positive affect during parents phone distraction (see Table 1). Repeated measures ANOVA (F (2, 150) = 7.16, p < .01; partial η^2 = .09) and post hoc comparisons also revealed that RSA decreased during the phone distraction condition (PD) (M = 4.61, SD = 1.67, t = -2.93, p < .01) relative to the initial (EN) (M = 4.81, SD = 1.70) and final social recovery (RC) conditions (M = 4.89 SD = 1.81, t = 2.88, p < .01) (see Figure 1). Repeated-measures ANOVA showed a similar effect for heart rate (HR) (F (2, 150) = 9.17, p < .001; partial η^2 = .011), with HR increasing significantly from the EN phase (M = 126.32, SD = 10.88) to

the PD phase (*M* = 128.48, *SD* = 10.94, *t* = -4.35, *p* < .001) but remaining slightly elevated following the PD phase compared to the EN phase (*t* = 2.19, *p* = .03). We also examined whether RSA Reactivity (change in RSA from the EN to phone PD condition) were linked to toddlers behavioral response to the PD condition and/or parents' self-reports about their own technoference. RSA withdrawal was linked to toddlers' decreased positive affect (*r* = .20, *p* = .035) and increased negative affect (*r* = .24, *p* = .013) during PD. Linear regression revealed that toddlers' RSA reactivity was related to parents' reports of technoference *B* = -.05, *SE B* = .02, β = -.25, *t* = -2.93, *p* = .004) and attitudes about technoference (*B* = .07, *SE B* = .03, *β* = .18, *t* = 2.11, *p* = .037). Together findings demonstrated that a majority toddlers experienced RSA suppression coupled with HR increase and a loss of positive affective tone during parents phone distraction and partial recovery when parents reengaged. Findings suggest that parents' mobile device distraction may be physiologically distressing to toddlers, resulting in momentary vagal withdrawal for some children and vagal augmentation for others. Parents' who endorsed attitudes that it was okay to use their mobile device in front of their child were more likely to have children who demonstrated vagal augmentation. Vagal augmentation to social challenges has previously been linked to poorer developmental outcomes for children, suggesting that parents' more frequent bouts of technoference may undermine toddlers' emerging regulatory abilities.

P2-H-415 - Maternal sensitivity and infant-mother attachment in a high-risk sample: The importance of naturalistic assessment

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Details

Attachment theory posits caregiver sensitivity to be the most important predictor of attachment security in infancy (Ainsworth et al., 1978). It is thus of interest that whereas Ainsworth et al. (1978) found strong prediction between mothers' sensitivity, assessed in naturalistic home settings, and infant-mother attachment, much of the work that followed Ainsworth did not. Meta-analyses (De Wolff & van IJzendoorn, 1997; Goldsmith & Alansky, 1987) found a mean link between sensitivity and attachment (*r* = .22) much smaller than that reported by Ainsworth et al. (*r* = .78), and even smaller among families of lower socioeconomic status (*r* = .15).

There could be a number of reasons for the low sensitivity-attachment links. A consistent theme throughout much of this work is that assessments of parental sensitivity and infant attachment were not naturalistic. Many studies assessed parental sensitivity in brief structured tasks that bore little resemblance to what naturally unfolds between caregivers and infants in the home. The Strange Situation, used to assess attachment in most of this work, suffers from this same criticism (e.g., Gaskins et al., 2017). Further, by force-classifying attachments into a limited number of categories, the SS classification system places constraints on statistical power and effect size.

The present study examined linkages between maternal sensitivity and infant attachment in a high-risk sample, using fully unstructured, naturalistic observations of maternal sensitivity (the Maternal Behavioral Q-Set) (MBQ; Pederson & Moran, 1995) and infant-mother attachment (the Attachment Q-Set) (AQS; Waters, 1995). One hundred sixty-seven African American mothers (mean age 27.74 years)

and their premature infants (51.8% female and 50.9% firstborn) were recruited from four urban hospitals in the mid-Atlantic region. All infants were born < 37 weeks gestational age and < 2500 grams as part of a larger NIH-funded study. MBQ home observations were obtained by a highly reliable observer team when infants were 3-4, 12, and 24 months. AQS home observations were obtained by a separate reliable observer team at 12 and 24 months. Infant temperamental "difficultness" at 3 months was assessed with the Infant Characteristics Questionnaire (Bates et al., 1979) to determine if maternal sensitivity-infant attachment associations were moderated by infant temperament.

Pearson correlations between MBQ and AQS scores are provided in Table 1. These correlations were, in the main, strong, ranging from .23 to .56 (mean = .42), and stronger than the mean effect sizes typical of studies using the SS. Subsequent regression analyses revealed that infant temperament moderated the link between maternal sensitivity at 12 months and infant attachment at 24 months. Post-hoc analyses revealed that mothers' sensitivity at 12 months significantly predicted 24-month infant attachment security among infants who were low-to-moderate in difficultness but not among infants at high levels of difficultness (see Figure 1).

When attachment and caregiver sensitivity were assessed naturalistically, maternal sensitivity predicted infant attachment security at higher levels than earlier work that used the SS to assess attachment. Naturalistic assessments of parent-child processes may be particularly important in family systems that are at high risk and/or that depart from Western norms.

P2-H-416 - Examining difference in fear-eliciting tasks: Variability in distress and associations with mother-infant interactions and maternal depression

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Details

This work sought to examine differences in infant distress reactions to several widely utilized fear eliciting stimuli. These different episodes were designed to elicit distress to novelty and are typically used interchangeably, with distress markers/scores often combined. However, these episodes involve different experimental manipulations (i.e., a human/social stimuli vs. objects, which may be stationary or move). This variability requires additional study of equivalence with respect to resulting distress and associations with mother-infant interaction dynamics, including maternal responsiveness, play reciprocity, interaction intensity, emotional tone, interaction tempo, and directedness of pay (i.e., which partner is directing play), as well as maternal depression. Links between interaction quality and infant fear have been previously examined (Gartstein et al., 2018), however, work is limited in the number of fear-eliciting manipulations and aspects of mother-infant interactions. Maternal depression has also been shown to account for significant changes in infants' fearfulness, with more severe symptoms leading to greater increases in fear (Gartstein et al., 2010).

Distress coding was completed for three separate fear-inducing tasks included in the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith & Rothbart, 1996): (1) stranger approach; (2) spider presentation; and (3) masks presentation. Distress codes consisted of facial distress rated on a 1-3

scale, with 1 indicating one facial region showing distress and 3 indicating all facial regions expressing distress. Vocal distress was measured on a 1-5 scale, with 1 indicating difficult to determine vocalizations and a 5 indicating full screaming. Composites were formed for four distress variables, referred to as total vocalizations, total distress vocalizations (levels 2-5), total distress expressions, and total distress (total distress vocalizations plus total expression). Interaction dynamics of sixty-three mother-infant dyads were coded for maternal responsiveness, reciprocity, intensity, direction, tone, and tempo during free-play. All variables were rated on a 7-point Likert-scale. Maternal depression was measured via the Edinburgh Postnatal Depression Scale (Cox et al., 1987)

Results of a one-way within groups ANOVA (Table 1) and post-hoc Sidak analysis showed significant difference in infants total and distress vocalizations during the spider and the masks task, but not between either task or the stranger approach. There was no significant difference in total expression of distress across the three tasks. A significant difference in total distress was observed, although post-hoc analysis did not identify specific tasks that differed. Simple correlations with interaction factors and maternal depression were computed (Table 2), revealing multiple significant associations between distress during the spider task and parent-infant interactions. Finally, hierarchical linear regression analyses were conducted for distress responses to the spider task, unique in demonstrating significant correlations with interaction dynamics. Results demonstrate that controlling for maternal depression revealed that infants who experience more reciprocal play express greater distress across all composites (b's=.47-.52; Mean b=.49).

P2-H-417 - Dreaming for empathy? Results from an online study into dreaming, sleep, and empathy in pre-schoolers

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Details

Introduction: Recent evidence links dreaming to empathic skills in adults (Blagrove, 2019). Empathy is thought to emerge during toddlerhood, and it is crucial for social skills development (Decety & Holvoet, 2021). Interestingly, dreaming seems to start developing in toddlerhood too, but little is known about this phenomenon and its purpose in development in children. Dream content changes with development shifting from egocentric content involving the self to more story-like content involving others (Sandor, 2015, 2016), suggesting that it might be related a gradual increase in children's social life. However, no empirical studies investigated whether the emergence of empathy in toddlers can be associated with dreaming content and sleeping patterns. Our large-scale online questionnaire study aims at exploring the association between dreaming, sleep and (child and parental) empathy in pre-schoolers.

Methods: Parents/carers of N = 32 2–6-year-old children (Target N = 300) were invited to fill out the online questionnaire study hosted on online experiment platform Gorilla. It includes the following questionnaires for parents to fill out about themselves (Empathic Quotient; EQ, Empathic Experience Scale; EES) and their children (Children's Behaviour Questionnaire; CBQ, Empathy Questionnaire;

EmQue). We developed our own 31-item developmental dreaming questionnaire called the Developmental Dreaming and Sleeping Questionnaire (DDSQ). We will use correlational analyses and mixed modelling to analyse the data.

Results: Data collection for this study is ongoing. Pre-liminary results show that the average age of first dream reports was 20 months (SD= 13.77 months). More empathetic parents (=higher scores on the EES) reported witnessing more dreams in their children (r = .39; p = .04). Toddler's night sleep duration was correlated positively with how often parents talked to their children about dreaming (r= .39, p = 0.03). Lastly, there was a marginally significant negative correlation between EES score and age at first dreaming r = -.41 (p = 0.065) and the same preliminary trend can be seen in the EmQue and in association with the reported frequency of dreaming, see Figure 1 A/B.

Discussion: Our preliminary findings indicate a positive association between empathy and dreaming. Analyses on the full dataset will enable us to investigate this association in more detail and with a greater statistical power. Future analyses on this data set will include machine learning approaches to pull out patterns in the narrative dream reports. This stream of research is exceptionally novel, as the role of dreaming and sleeping in the emergence of social skills such as empathy has never been investigated before. However, acquiring a better understanding of the mechanisms behind the relationship between these two aspects in early childhood can inform intervention strategies to improve social skills, leveraging dreaming reports and sleep training.

P2-H-418 - Maternal mental health during the COVID-19 pandemic: findings from the Iracema cohort study in Fortaleza, Northeast of Brazil

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Details

Background and aim: Stressors associated with the COVID-19 pandemic affected maternal mental health worldwide. This study aimed to examine changes in maternal mental health during the COVID-19 pandemic in Fortaleza, Brazil, and explore associated risk factors. **Methods and Results:** We used three survey rounds of a cohort study conducted between January 2021 and March 2022. In each round, maternal mental health status was assessed using the 20-Item Self-Reporting Questionnaire (SRQ-20). We used cross-sectional and longitudinal multinomial logistic regressions with robust variance to assess risk ratios associated with maternal mental health. Characteristics of participants reporting chronic presence of common mental disorders (CMD) over time were examined. Factors associated with worsening mental health status over time were tobacco and alcohol use, and having missed medical appointments due to fear of COVID-19, while maternal education was associated with slight improvements. Women who were at higher risk for chronic depression and anxiety were more likely to use tobacco, to have experienced a decrease in personal income, and to have less education than women who were not at risk. **Conclusions:** There is a need for more concerted efforts in maternal health

communication and access to health services during public health emergencies, as well as mental health care during and after pregnancy.

P2-H-419 - The Effect of Metalinguistic Awareness on Theory of Mind – preliminary findings

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Details

Title: The Effect of Metalinguistic Awareness on Theory of Mind – preliminary findings

Objective: Bilingual children have precocious Theory of Mind (ToM) skills, that is skills to distinguish between one's own and other's knowledge, desires and intentions (Schroeder, 2018; Diaz & Farrar, 2018). It has been argued that this is due to enhanced metalinguistic awareness, that is bilinguals' experience to link two representations for the same referent (two names for the same object). This study examined the effect of metalinguistic awareness training on ToM.

Methods: We tested 32 participants (target: 34) three- to four-year-old monolingual children in the United Kingdom. They took part in a pre-test, a training period of eight sessions (twice per week for 4 weeks) and a post-test. For the pre- and post-test, children were tested on three ToM tasks (Director task, Sally Anne, Unexpected content), an executive function (EF) task (Blue dog/red dog), vocabulary (British Picture Vocabulary Scale), and number knowledge (Numeral identification). For the training sessions, children were randomly assigned to either metalinguistic training (experimental group) or numerical training (active control group). For the metalinguistic training, we used the Synonym Judgement task, which had previously been found to be related to enhanced ToM skills (Diaz & Farrar, 2018; Fan et al., 2015; Hsin & Snow, 2017). For the numerical training, we used "the Great Race" task (Ramani & Siegler, 2011). We expected metalinguistic awareness training to improve ToM, with EF and vocabulary knowledge as potential moderators.

Results: Tables 1 show preliminary results. A two-way ANOVA was carried out on the Director Task, the Sally Anne, and the Unexpected Content task with group as between-subject factor and timepoint as within-subject factor. For the Sally Anne task we found a significant effect of group (F (1) = 9.54 p = .003), with children in the metalinguistic training group scoring higher at both time points. For the Director task, we found a significant effect of time (F (1) = 9.99, p = .003), with lower scores post training compared to pre training. For the Unexpected content task, we found neither an effect of group (F (1) = 2.66, p = .11) nor time (F (1) = 0.001, p = .97). In addition, there was no significant interaction between groups and time on any of the tasks.

Conclusion: These preliminary results suggest that metalinguistic awareness training does not lead to increased ToM skills. But our training might not have been extensive enough to lead to changes, especially when compared to the extensive experience of a bilingual child.

Further analyses will investigate whether children improve on the training task across sessions and whether improvement on the training task is related to changes between pre- and post-test. We will

also test whether children who followed the numerical trained exhibit improvements in numeral knowledge. Furthermore, we will investigate whether inhibitory or vocabulary skills pre-intervention might interact with the effect of the intervention, and whether improvements in ToM (or numeral knowledge) might be related to improvements in inhibitory or vocabulary skills.

Keywords: ToM, Metalinguistic Awareness, Executive Function, Preschool children, Monolinguals

P2-H-420 - Emergence of infants' fairness expectations in resource collection events

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Details

From a young age, children demonstrate an understanding of fairness, shaping their expectations and behaviors. Past literature has established that Western infants as young as 12 months old expect fair resource distribution (Sloane et al., 2012; Ziv & Sommerville, 2017) and prefer fair distributors (Burns & Sommerville, 2014; Geraci & Surian, 2011). However, fairness principles can apply not only to resource distribution events but also to resource collection events, such as when resources are taken away and redistributed. While Sobel et al. (2023) showed that children are sensitive to principles of equity in resource collection by 6 years old, it is unknown whether infants apply fairness principles to resource collection events. Critically, infants appear to reason differently about giving and taking actions in other social domains (e.g., Tatone, Geraci, & Csibra, 2015; Yin, Csibra, & Tatone; 2022), suggesting the development of fairness expectations may differ between resource distribution and collection events.

Experiment 1 examined infants' fairness expectations in resource collection events using a violation-of-expectation paradigm. Infants between 14 and 17 months of age (N = 56; M = 15 months, 30 days; range = 14 months, 3 days –17 months, 30 days; 29 females, 27 males) watched videos in which two agents had four cookies on each of their plates. Next, a collector either took two cookies from each (2:2 collection) or one from one agent and three from the other (1:3 collection). Results showed a significant interaction between condition and age group, β = 7.99, SE = 2.51, p = .002. Infants aged 16 to 17 months old looked longer to unequal collection events than to equal collection events, β = 6.52, SE = 1.63, p < .001, indicating that the unfair event violated older infants' expectations for equal collection. However, there was no difference in looking time among 14- and 15-month-olds (p = .45). These findings raise the possibility that fairness expectations in collection events emerge at around 16 months old, after their typical emergence for distribution events.

To better understand these developmental differences, Experiment 2 will evaluate infants' fairness expectations for distribution events which match the overall number of resources and number of resources taken away in Experiment 1. Infants between 14 and 17 months old will watch videos with two agents starting with two cookies each, later receiving more from the distributor resulting in equal (4:4) or unequal (3:5) outcomes. Given that 14- to 15-month-olds demonstrate robust fairness expectations for resource distribution events (e.g., Ziv & Sommerville, 2017), it is possible that infants in

both age groups will look longer to unfair distribution events in Experiment 2. Alternatively, 14- to 15-month-olds may not show significant differences in looking in Experiment 2 given that they must track a larger number of resources than in typical distribution studies.

As such, Experiment 2 will elucidate whether the patterns found in Experiment 1 reflect conceptual differences in the actions (i.e., giving or taking) or rather, the cognitive demands required for tracking larger amounts of resources. Overall, this work highlights how infants begin to reason about fairness in a wider range of ecologically representative contexts beyond simple resource distribution events.

P2-H-421 - Infants' preference for a comforting character is related to their frontal asymmetry response but not to caregiving quality

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Details

Infants have been shown to prefer pro-social over antisocial behavior when they observe third-party interactions. One form of pro-social behavior - comforting someone - received somewhat less attention. Existing studies paint a mixed picture about the developmental course and neural underpinnings of infants' evaluation of comforting. While expectations for comforting in third-party interactions have been shown to emerge universally as early as 4 months (Jin et al, 2018), individual differences related to caregiving quality and neural responses have also been identified in older infants (Johnson et al, 2007; Biro et al, 2015, 2021).

In the current study, we investigated if infants' preference for comforting over ignoring behavior - assessed by a choice task at 12 months - could be predicted by (1) infants' frontal asymmetry (FA) responses while observing such behaviors at 10 months, (2) their attachment security, (3) or the level of sensitive parenting by their mothers. Greater relative right frontal activity is associated with regulating of "withdrawal emotions" such as sadness and distress, while greater left frontal activity is associated with "approach emotions" such as joy and interest. We hypothesized that those infants who show more approach-like tendencies in response to observing comforting compared to ignoring behavior, and those who are securely attached and have more sensitive mothers, will be more likely to choose the comforting character.

The current sample comprises 88 infants (49 boys and 39 girls). At 10 months, during the EEG measurement (128-electrode EGI net), infants watched two types of animations that involved two characters, a larger and a smaller one moving together and then separating from each other. The separation was accompanied by a crying sound and ended either with the larger character returning ("Comforting") or going further away ("Ignoring"). The animations were shown in 4 blocks. Each block contained 3 animations with the same type of outcome. FA (6-9 Hz) was calculated between 11 pairs of

frontal electrodes for the two types of animations. At 12 months, infants' attachment security was assessed using the Strange Situation Procedure. Infants' preference was assessed by letting them choose between two 3D characters after watching animations of comforting and ignoring behavior of these characters 4 times each. Touching, grabbing or pointing at one of the characters were counted as a choice. The order of the animations, color and side placement of the characters were counterbalanced. Coding of maternal sensitivity was based on mother-infant free-play sessions at 10 and 12 months.

We found that the difference score between FA for the comforting and ignoring animations predicted infants' preference (B=-13.03, S.E.=6.15, Wald=4.48, p=.03). A relative more approach-like FA for comforting behavior predicted choosing the Comforting character. Attachment classification and maternal sensitivity, however, were not related to the preferences, ps=.62. Our findings suggest that individual differences in the strength of motivational tendencies for prosocial vs. antisocial behaviors predict the emergence of overt prosocial preferences in infants. This conclusion is supported by a similar link found for helping/hindering in Cowell and Decety (2015).

P2-I-422 - Emotion dynamics of toddlers' peer conflicts and teacher interventions in early care and education (ECE) settings

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Details

Toddlers have much exposure to peers as most children under age three experience some type of non-parental child care (Deynoot-Schaub & Riksen-Walraven, 2006). Peer interactions during the first three years are less emotionally regulated (Barthel et al., 2018) and more conflictual (Clarke et al., 2019) than those in later childhood. This provides opportunities for emotion socialization by adults (Kvist & Cekaite, 2021), which highlights the important role of teachers in supporting the development of emotion regulation abilities for toddlers in ECE settings (Clarke et al., 2019). Yet it is unknown how toddlers' emotions elicit teachers' responses in ECE classrooms. This study examined toddlers' emotions during peer conflicts and teachers' interventions.

Seventy-six toddlers (40 female, M_{age} = 32.94 months, *SD* = 4.92 months; Range: = 22 – 36 months; 73% White, 12% Black, 10% Asian, and 5% Latino) were observed during free play in classrooms mostly in university-affiliated child development programs. Using ELAN software trained coders first identified toddlers' peer conflicts, vocalizations, emotions (i.e., anger and sadness coded multimodally; Arsenio & Lover, 1997), and aggression, as well as teachers' interventions. Next, toddlers' vocalizations were coded into emotion-related vocalization types (i.e., scream, yell, cry, whine/fuss) by another trained coder naive to original emotion codes. Timestamps of each event were exported into an EXCEL file to examine contingencies (events occurring within 5 seconds). Of particular interest was how toddlers' multimodal emotions and emotion-related vocalizations corresponded with one another and elicited contingent teacher interventions.

On average, toddlers engaged in 2.5 conflicts per 30-minute observation (Range = 0 to 10). Victims of conflicts responded vocally to most disputes (68%) and emotionally half the time – anger (23%) and sadness (25%). Aggression was present in sixty percent of conflicts. Teachers usually intervened in conflicts (82%). Emotion responses typically included a vocal response – anger vocalizations (18%) and sadness vocalizations (23%). Toddlers expressed either a scream (20%), yell (23%), cry (20%) or whine/fuss (14%) in most conflicts (62%).

Toddlers' anger vocalizations significantly corresponded with screams (36%), X^2 (1, 185) = 15.07, p < .001, and yells (35%), X^2 (1, 185) = 5.96, p =.02, with less categorized as cries (22%) and fusses/whines (8%). Most sadness vocalizations were categorized as cries (65%), X^2 (1, 185) = 84.21, p < .001, compared to yells (13%), whines/fusses (13%), and screams (10%). Three logistic regressions examined toddlers' 1) vocalization, emotion, aggression, and an Emotion x Vocalization interaction, 2) vocalization, anger vocalization, and sadness vocalization, and 3) scream, yell, fuss/whine, and cry with teacher interventions. Toddlers' Emotion x Vocalization interaction, b = 1.71, p = .04, sadness vocalizations, b = 1.94, p < .001, and cries, b = 2.04, p < .001, all significantly predicted subsequent teacher interventions in their models (see Table 1 for effect sizes). No other variables were significant. Findings illustrate that toddlers' multimodal sadness expressions that included a vocalization and cries increased the odds of eliciting teacher interventions by six to eight times (see Figure 1). Implications of examining early emotion dynamics in ECE settings for social-emotional competence will be discussed.

P2-I-423 - Ecological momentary assessment of caregiver's daily stress and perception on infant affect

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Details

Infant's emotionality or affect is one of the earliest indicators of socioemotional development. Infant emotionality is mostly studied through the lens of temperament, which characterizes infants' attention, activity levels, emotion reactivity and regulation (Rothbart, 2011). The bidirectional influence between parents' and infants' affect has been extensively examined throughout the years, especially in the context of infant affect and parental stress (e.g., Mäntymaa et al., 2006; Oddi et al., 2013). Stress and affect are not static in nature and fluctuate relative to daily interactions and events. However, most studies have measured these through retrospective questionnaires or behavioral observations during a laboratory visit. Few studies have measured these moment-to-moment within a more naturalistic context and without recall bias. Ecological Momentary Assessments (EMA) captures participants' momentary states in their everyday lives though daily self-reported questionnaires. EMAs have been implemented mostly with health and adult research, rarely with infant research, and none with both parents and their infant. Thus, the current study will make a novel contribution by further establishing the relations between parental affect and parental perception of infant affect with higher ecological validity and less biases. Our poster will test the following two research questions:

Question 1: We will examine the affective synchrony between primary and secondary caregivers. H1) We hypothesize that primary caregivers will show stronger synchrony with their infant compared to secondary caregivers. The extent of the synchrony will be related to the time spent with the infant. Question 2: We will explore the directionality between caregivers and infant moment-to-moment affect. H2) We expect a stronger bidirectional relation between primary caregivers than secondary caregivers.

The current study will use data from an ongoing study. Primary parent, secondary parent, and infant data are being collected when the infant was either 3 to 20 months of age. Our current sample thus far consists of 13 families (primary and secondary caregivers) who completed up to 84 surveys within 14 days (per caregiver; M = 62; SD = 23.8). We expect to collect 20 families by the time of the conference. Parents report momentary negative affect using EMA surveys up to six times a day and for up to fourteen days. In the same momentary surveys, they also report their infants' affective states (negative and positive affect).

For data analysis, we will conduct a dyadic multilevel model for each parent. Each model will examine the concurrent relations between parent negative affect and infant's positive and negative affect (H1). In a follow up analysis, the amount of time spent with the infant (proportion of surveys completed while interacting with the infant) will be related to the "synchrony" parameters. In a second set of models, we will conduct dyadic cross-lagged models for each parent. Each model will examine the concurrent and lagged relations between parent negative affect and infant's positive and negative affect, allowing us to test the temporal directionality of these associations (H2). Overall, this study will be the first to examine parent daily stress and parental perception on infant affect measured via EMA .

P2-I-424 - Is the link between fearful temperament in infancy and internalizing problems in toddlerhood moderated by attention biases to threat?

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Details

Although early fearful temperament is among the strongest risk factors for later internalising problems, not every child with this disposition develops elevated symptoms (Clauss & Blackford, 2012; Sandstrom et al., 2020). It is therefore crucial to further study the nature of this relation, and determine other risk factors that, in interaction with temperament, may enhance the risk for internalising psychopathology. Attention biases to threat were proposed to strengthen this link between fearful temperament and later internalising problems (Pérez-Edgar et al., 2010; 2011). Attention biases to threat refer to the tendency to prioritize the processing of stimuli that signal threat and are proposed to be causally linked to anxiety in adults and children (Abend et al., 2018; Bar-Haim et al., 2007; van Bockstaele et al., 2014). Despite being a risk factor for anxiety later in development, an attention bias to threat emerges as part of the typical development. Between 5 and 7 months of age, infants start to look longer at and take longer to disengage from fearful versus happy faces (Leppänen & Nelson, 2012; Vaish et al., 2008). The links of this early attention bias to later fearful temperament or internalising problems remain to be explored. The only study on this association found no significant links between early attention biases to fear stimuli at 8 months and socio-emotional problems at 24 months of age (Eskola et al., 2023).

In the current study (*N* = 157) we focused on stability in early fearful temperament to later fearful temperament, and links to internalizing problems and depression/anxiety. We also explored the moderation of these links by attention biases. Infant attention biases to threat were measured in an eye-tracking experiment with dynamic facial expressions of fear and anger (versus happiness) when children were 6 (*n* = 53), 12 (*n* = 49), or 18 (*n* = 47) months old (Aktar et al., 2021). Attention biases were computed by subtracting average fixation duration for happy faces from the duration of fixation to fearful and angry faces. Infant fearful temperament was measured via parental reports concurrently with task completion, and then 24 months later, together with internalising problems using standardised questionnaires.

Preliminary results suggest a significant link between higher levels of fearful temperament in infancy and toddlerhood years (β = .19, *SE* = 0.09, *p* = .030), that was not moderated by infant attention biases (*p* = .703). Child internalising problems were not predicted either by fearful temperament (*p* = .299), or attention biases (*p* = .508), or their interaction (*p* = .507). In contrast, the link between infant fearful temperament and later depression/anxiety problems was significantly moderated by infant attention bias, such that the link between fearful temperament and later depression/anxiety problems was negative for children with high levels of attention biases to threat, whereas it was positive for children with low or moderate levels of attention biases (β = -.94, *SE* = 0.30, *p* = .020). The findings provide some support for the idea that typically emerging infant attention biases may shape individual trajectories linking early fearful temperamental dispositions to later depression/anxiety, but not necessarily enhance the risk of depression/anxiety in temperamentally fearful children.

P2-I-425 - From inhibited infants to timid toddlers: The effect of intrusive maternal parenting on early life fear trajectories

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Details

Fear develops in a linear, increasing pattern across infancy and toddlerhood as children gain independence (Gartstein et al., 2010). Although this trajectory of fear development is functional in helping keep infant safety in check
as they explore their environments (Adolphs & Andler, 2018), very high levels of fear can lead to internalizing psychopathology later in childhood (Buss et al., 2013). Prior research has demonstrated that sensitive maternal parenting
behaviors and secure attachments between mothers and infants are associated with slower, more gradual increases in fear across infancy (Braungart-Rieker et al., 2010). Intrusive maternal parenting, on the other hand, tends to be
associated with steeper fear trajectories (Barnett & Scarmella, 2017), possibly because intrusive mothers tend to limit child autonomy and have trouble helping children regulate emotions like fear (Lincoln et al., 2017). The goal of
our study was to add to this literature by examining the longitudinal role of maternal intrusiveness on fear across infancy and toddlerhood.

Participants included 410 mother-infant dyads who visited the lab when infants were 10-, 24-, and 36-months old. Mothers reported on child fear using the Infant Behavior Questionnaire (Gartstein & Rothbart, 2003) at 10-months, the Early
Childhood Behavior Questionnaire (Putnam et al., 2006) at 24-months, and the Children's Behavior Questionnaire (Rothbart et al., 2001) at 36-months. At 10-months, mothers also participated in two interaction tasks with their infants
(peek-a-boo and toy play), which were recorded and later coded for maternal intrusiveness using a 1 (none) to 4 (high) point Likert scale (Smith et al., 2004). We examined three growth curve models using Mplus (Muthen & Muthen, 2017).
In Model A, we centered the fear intercept at 10-months, in Model B we centered the fear intercept at 24-months, and in Model C we centered the fear intercept at 36-months. The conceptual model is depicted in Figure 1. The use of these
three models allowed us to test the effect of maternal intrusiveness during infancy on initial fear levels at each age, while also assessing the growth trajectory of fear across infancy and toddlerhood. Model fit and estimates for each
model are shown in Table 1. All three models achieved acceptable fit. Maternal intrusiveness at 10-months positively predicted the fear intercept in Models B and C, but not Model A. Maternal intrusiveness at 10-months did not predict
the slope of fear in any of the models.

Overall, our results demonstrate that maternal intrusiveness predicts interindividual differences mean in fear during toddlerhood at ages 24- and 36-months, but not at 10-months (i.e., intercept). Interestingly, maternal intrusiveness
at 10-months did not predict intraindividual change (i.e., slope) in fear across infancy and toddlerhood. Our data suggest that maternal parenting during infancy is important in setting the stage for fear responses later in development. More research is needed to identify factors predicting the intricate longitudinal relations among maternal parenting and child fear trajectories, but this study provides preliminary insight for such.

P2-I-426 - Indirect effect of maternal emotion regulation on infant behavior problems

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Details

Eisenberg's (1998) emotion socialization model highlights the processes by which parental characteristics affect how children experience, express, and regulate emotions. Research shows that mothers' emotion regulation skills are associated with higher maternal sensitivity (Leerkes et al., 2023; Shaffer & Obradovic, 2017). Relatedly, maternal sensitivity is associated with infants' better physiological regulation (RSA withdrawal) in response to stressors (Conradt & Ablow, 2010). Furthermore, maternal sensitivity predicts lower behavior problems directly (Leerkes et al., 2009) and indirectly via infant regulatory skills (Calkins et al., 1998). The goal of this study was to empirically test

Eisenberg's (1998) emotion socialization model to determine if maternal emotion regulation, assessed physiologically and via self-report, indirectly affects infant behavior problems via maternal sensitivity and children's physiological regulation.

Participants were 299 mother-infant dyads (47.5% Non-White, 51.2% male infants). During their third trimester of pregnancy, women completed questionnaires assessing demographics, emotional risk (depression, anxiety, personality), and emotion regulation difficulties (Gratz & Roemer, 2004). Mothers' SCL and heart rate (to derive RSA) were collected during baseline and while viewing four videoclips of crying infants; change scores were calculated to reflect SCL augmentation and RSA withdrawal. At 2 months, mother-infant dyads participated in a baseline, free play, and the still-face task. Maternal behavior (sensitivity to distress and non-distress, intrusiveness, detachment, positive and negative regard) was rated and averaged across the free play and still-face and infant RSA was collected during all tasks. Total maternal sensitivity reflected high sensitivity and positive regard, and low intrusiveness, detachment, and negative regard. At 6 months, infant RSA was collected during baseline, arm restraint, and still-face tasks. A change score was calculated to reflect RSA withdrawal during emotion-eliciting contexts. At 1 year, mothers reported on infant behavior problems (Briggs-Gowan et al., 2004) and maternal behavior was rated by observers during a frustration and fear task.

A structural equation model (Figure 1) was estimated in Mplus and demonstrated acceptable model fit (χ^2 (195) = 361.33, p = .000; RMSEA = .05; CFI = .92; SRMR = .07); missing data were handled via full information maximum likelihood. Covariates included mothers' age, education, income-to-needs ratio, emotional risk, infant RSA at 2 months (to control for prior effects), and total maternal sensitivity at 1 year (to control for concurrent effects). Maternal emotion regulation difficulties were associated with lower maternal sensitivity at 2 months. In turn, lower maternal sensitivity at 2 months was associated with higher infant behavior problems at 1 year. Bootstrapped confidence intervals demonstrated the indirect effect from maternal emotion regulation difficulties to higher infant behavior problems was significant (b = .49, 95% CI [.05, 1.13]). There were no main or interactive effects of mothers' SCL augmentation and RSA withdrawal. Additionally, infant RSA withdrawal was not a significant mediator of the association between maternal sensitivity and infant behavior problems.

Results demonstrate partial support for Eisenberg's (1998) model and highlight that mothers' prenatal emotion regulation difficulties have lasting consequences for infants' behavior problems via its impact on maternal sensitivity. Implications for future research and prevention/interventions will be discussed.

P2-I-427 - Mothers' and fathers' depressive symptoms and coping with children's negative emotions: A dyadic model

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Details

Introduction:

How parents respond to their children's emotions is a direct form of emotion socialization (Shewark et al., 2015). When parents are struggling with depression, it may become more difficult to provide supportive responses to children's emotions. Parents' depression has been associated with increased negative parenting practices (Tissot et al., 2016) and increased negative outcomes for children (Middleton et al., 2009). Parental depression may contribute to less sensitive parenting practices, which can be particularly salient to toddlers' socioemotional development (e.g., self-attributions, theory of mind, emotional/behavioral regulation). Although a link has been established between parental depression and children's outcomes, the way in which parents with depression respond to children's negative emotions is understudied. Examining the specific mechanisms through which parental depression may contribute to emotion socialization practices is warranted. Further, most research is within individuals and does not examine the dyadic nature of the parenting relationship.

Study Aim:

The aim of this study is to examine the dyadic associations between parents' of toddlers reports of depression and parents' responses to children's negative emotions.

Materials and Methods:

Participants were 166 U.S. mothers and fathers (N=83 parental dyads; 7.2% Black, 59% white, 33.7% other) and their toddlers (N=83, 41 boys, 42 girls; *M*age = 28.98 months, *SD* = 4.34). Most dyads were college educated (50.6%), employed (48.2%), and living together (90.4%). Participants were recruited from a childcare center in the U.S. through flyers sent home with their child. Families came to a laboratory setting to complete the study. The Center for Epidemiologic Studies Depression Scale (Radloff, 1977) was used to measure parental depression and the Coping with Toddlers' Negative Emotions Scale (Eisenberg et al., 1994, 1996) was used to assess parents' unsupportive responses (e.g., punitive reaction, ignoring their toddlers' negative emotions) to their toddlers' negative emotions. An Actor-Partner Interdependence Model (Kenny, 1996) with distinguishable dyads was analyzed in Mplus 8.3 (Muthén & Muthén, 1998-2017).

Results:

Results (Figure 1) indicated that mothers' reports of depression were significantly associated with their own (b= .427, $p < .001$) and their partner's (b = .228, $p = .038$) unsupportive responses to children's emotions. Further, fathers' reports of depression were significantly associated with their own (b = .427, $p < .001$) and their partner's (b = .228, $p = .038$) unsupportive responses to children's emotions.

Conclusions:

Both mothers' and fathers' depressive symptoms were significantly positively associated with their own and their partners' unsupportive responses to toddlers' emotions. These findings may be explained by spillover effect, through which distress caused by increased depressive symptoms may contribute to more negative parent-child interactions (Tissot et al., 2017). Depressive symptoms may contribute to withdrawal from the child or increased negative affect (Middleton et al., 2009), which may impact parenting behaviors, and may contribute to internalizing and externalizing symptoms in children (Middleton et al., 2009). This is particularly important for toddlers, who rely on parents to help them

learn emotional skills such as self-soothing, attributions about themselves (e.g., "good" or "bad"), and labeling and expressing emotions appropriately.

P2-I-429 - The neural and behavioural developmental mechanisms underlying emotional eating in 12- and 18-month-old infants.

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Details

Background

Eating in response to emotions (emotional eating) is a complex behaviour that encompasses appetite self-regulation, emotion regulation and interoceptive abilities. As children's abilities across these domains develop, individual differences may determine their effects on responding to food cues in emotional contexts. The present studies examined the developmental mechanisms that define emotional eating. We assessed the extent to which factors such as parental feeding practices and infants' emotion regulation strategies contribute to [a] emotional eating behaviours and [b] motivational approach and avoidance to foods.

Methods

We examined infants' brain activity (Study 1 – 12-month-olds) and eating behaviour (Study 2 – 18-month-olds) in relation to emotional eating. For both studies, parents completed a questionnaire battery before attending the lab and upon arrival, infants ate their usual lunch. In Study 1, whilst wearing an EEG cap, infants underwent a frustration task before watching a series of pictures of liked foods (high and low energy dense) and non-foods (animals and plants). Frontal alpha asymmetry was examined to indicate motivational approach or avoidance tendencies toward the stimuli.

Study 2 comprised two lab visits counterbalanced for control and experimental conditions. After lunch, infants engaged in either free play [control] or a frustration task [experimental]. Immediately following the task, an Eating in the Absence of Hunger paradigm was conducted to examine calorie intake in response to negative affect versus control.

Results

Preliminary analyses of Study 1 (N = 48) show that left frontal asymmetry (motivational approach tendencies) is higher for non-food stimuli than for food stimuli in the absence of hunger. This effect was pronounced when satiety responsiveness traits were higher. Brain activity was not predicted by behavioural reactivity to the frustration task, nor any parental feeding practices.

In Study 2 (N=51), toddlers ate a similar amount of energy regardless of condition (control [M=38.6kcal] vs experimental [M=44.5kcal]). Importantly, ~15kcal more energy was consumed by infants that ate more after experiencing negative affect, compared with children that ate more energy in the control

condition. Additionally, higher behavioural reactivity (e.g. distress vocalisations, struggle) to the frustration task was related to larger amounts of energy consumed. Parental feeding practices did not predict energy eaten in the absence of hunger.

Conclusions

Frontal alpha asymmetry is a good infant marker of approach and withdrawal tendencies towards foods. In the absence of hunger, satiety responsiveness traits predict motivational tendencies towards food stimuli. At 18 months, we found individual differences in infants' tendencies to regulate emotions with food: some children eat more in response to negative affect, whereas others consume more when experiencing positive or neutral affective states. Furthermore, infants may consume more energy if they display reactivity to emotional situations, indicating poorer emotion self-regulation. At 12 and 18 months, parental feeding practices may not be as important as individual differences in predicting responses to food cues in emotional contexts. This research considers the complexity of both caregiver and infant factors and offers novel hypotheses for the investigation of the mechanisms involved in the ontogeny of eating behaviours.

P2-I-430 - The role of coparenting, temperament, and sensory processing in infant attachment at 12 months

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Details

Previous research has focused on contextual and child factors that associate with infant attachment. Competitive coparenting has been found to associate with lower security directly (Caldera & Lindsey, 2006) and indirectly via maternal emotional availability (Kim et al., 2021). Furthermore, certain temperamental characteristics like shyness and irritability can challenge the parent's ability to respond consistently and appropriately, thus increasing the risk for an insecure attachment (Hong & Park, 2012. Research also supports individual differences in sensory processing of children and adults, including differences in sensory threshold and regulation of sensory information. Adult retrospective studies linked sensory sensitivity (i.e., low threshold) to relationship anxiety and uncaring parenting that encourages dependency (Liss et al., 2005). It is not clear how sensory processing relates to temperament and whether it may contribute to attachment security. In this study, we investigated the role that coparenting, temperament, and sensory processing may play in predicting infant security at 12 months. We expected to find significant associations between these factors and attachment security. Participants were 42 first-born infants, and their parents from a longitudinal study on transitions to parenting. The parents' ages ranged from 23 to 38 years. The sample was 80% White and 75% middle-class. Participants completed structured and non-structured tasks designed to assess parent-child interactions, sensorimotor, and communication skills. The sessions were 2-hours long and were video-taped. Two trained observers performed the Attachment Q-Sort (Waters, 1987) and coded security, dependency, physical contact with mother, proximity to mother, interaction with other adults, and social interaction with mother (Posada, et al., 1995). Mothers and fathers completed the Sensory Profile (Dunn, 1999). Temperament was assessed at 3 months with Bates' Infant Characteristics

Questionnaire (ICQ) and at 12 months with Carey's Infant Temperament Questionnaire (ITQ). We used the Coparenting and Family Rating System (CFRS, McHale et al., 2000) to code coparenting and created two factors: synergetic and antagonistic coparenting at 3 and 12 months. Results showed high consistency in mother-rated fussiness from 3 to 12 months, r (32) = .65, p < .001. Fussiness at 3 months predicted low adaptability and sociability at 12 months. Security was associated with synergetic coparenting, r (42) = .46, p = .002, thus complementing existing literature that showed a negative association with competitive coparenting (Table 1). Security was also negatively correlated with fussiness at 3 months, r (41) = -.38, p = .014, mother-rated low registration, r (30) = -38, p = .039, and father-rated sensation-seeking, r (30) = -.42, p = .022 (Table 1). There were no significant correlations between sensory processing variables and temperament, signaling that based on the measures used here, these are two different constructs that make unique contributions to infant security. Regression analyses revealed that only the sensory processing variables were significant predictors of security, explaining 37% of the variance (Table 2). It is speculated that infants who seek sensory stimulation but tend to miss information from the environment (low sensory registration) may be missing parental cues that enhance feelings of security or experience more anxiety. Future research may explore these pathways to insecurity.

P2-I-431 - Relationship between mothers' interaction style and infants' attention to facial expressions of emotion

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Details

[**Objective**] Previous evidence revealed links between parental negative emotions and infants' attention to facial expressions of emotion in community samples (Evin, et al., 2018). However, there is little study addressing the influence of comprehensive parenting style on infants' reactions to facial expressions. This study aims to investigate the associations between maternal interaction style and infants' attention to emotional faces in Japan, with a longitudinal design to explore the causal relationship.

[**Methods**] This study examined the infants' temperament, their reaction to emotional faces, and mother-infant interaction at two times, Time 1= 6 months (N = 30), Time 2 = 9 months (N = 20). Fourteen pairs of mothers and their children participated in the experiments both at Time1 and at Time2. Infants' temperament was measured using the Infant Behavior Questionnaire (IBQ). Infants' fixation time to sad/angry/happy/neutral faces on the monitor were examined in the experiment room. Finally, the infants and their mothers were asked to complete an interaction session (playing blocks) in the playroom and were observed by two researchers, their behaviors were valued using the IRS (Interaction Rating Scale, a behavior index of children's social skills and parenting, Anme, et al., 2010). The five parental dimensions focus on caregivers' respect for the autonomy/responsiveness/empathy/cognitive/social-emotional development of children. The correlations between these variables and the changes from Time1 to Time2 were analyzed.

[**Results**] There was a significant negative correlation between mothers' interaction style (IRS_Parent_total) and infants' attention time to happy/sad faces at Time2(9m) (r = -. 45, r = -.47, p <

.05). No significant correlation was found at Time 1(6m). The mothers' IRS scores on IRS_10 (Respect for child's social-emotional development) significantly increased from Time 1 to Time2 (t = -2.5, p < .05). Furthermore, it was found that there was a significant negative correlation between IRS_10_Time1 and infants' attention time to angry faces at Time2 (r = -.63, p < .05), and a significant negative correlation between infants' temperament (Effortful-Control_Time1) and mothers' interaction style (IRS_Parent_total_Time2) (r = -.54, p < .05).

[**Conclusions**] The results showed that the temperament of infants at 6 months was related to mothers' interaction style at 9 months. On the other hand, the mothers' interaction styles at 6 months and 9 months were associated with infants' attention time to emotional faces at 9 months. It suggests that mothers' interaction style (especially interaction skills on social-emotional development), rather than infants' temperament, might directly affect children's reactions to emotional faces. We are collecting more data to examine the mediation effect of mothers' interaction style between infants' temperament and their reaction to facial expressions with a larger sample and multiple times in the future.

P2-I-432 - Influence of maternal emotional expression and familiarity in maternal singing versus speech on infant behaviour

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Details

Introduction – Maternal singing to infants is distinguished by its ritualistic consistency and emotional richness, notably enhancing emotional expressiveness through vocal timbre (Bergeson & Trehub, 2002; Trehub et al., 2010). This communication modality not only modifies the maternal voice but also positively affects facial expressions, particularly increasing the frequency of maternal smiles compared to speaking, thus engaging infant interest (Nakata & Trehub, 2004; Trehub et al., 2016). Further research suggests that songs from primary-caregiver elicit unique arousal and behavioural responses in infants, markedly different from those to speech (Cirelli & Trehub, 2020; Kragness et al., 2022). This study aims to investigate the effect of combined auditory and visual emotional cues, specifically smiling, in maternal singing versus speech, on infant emotional responses within the familiar environment of the infant's home.

Methods – This study employed a within-subjects experimental design with 28 mother-infant dyads (mothers aged 22 – 44 years; infants aged 5 – 11 months, M = 231 days, 15 females). Participating mother-infant interactions were video-recorded via webcam and the Lookit platform (Scott, & Schulz, 2017), examining the effects of maternal interaction (IV) through singing versus non-singing interaction on infant behaviour (DV). Participants were recruited through Lookit, with procedures for informed consent and participation outlined through instructional videos and detailed on the Lookit website. The sequence of maternal interaction in the study was semi-counterbalanced to mitigate order effects, with mothers choosing the order of interactional sessions. These sessions, lasting 5 minutes each and spaced a week apart, were preceded by different video-recorded and verbal consents. For analysis, a representative 90-second segment was analysed for specific behavioural responses, utilising the Infant Behaviour Rating Scales (de l'Etoile, 2006).

Results – The analyses of physical, vocal, and facial response domains, which deviated from a normal distribution, were conducted using the Wilcoxon signed-rank test (Table 1). In contrast, the cognitive response domain, meeting the normality assumption, was analysed with a paired-samples t-test (Figure 1). Across all examined domains, statistical analyses showed no significant differences in infants' responses to maternal singing versus speech, with $p > .05$. Consequently, infants demonstrated similarly positive behaviours in terms of attention, physical and vocal engagement, and facial expressions, regardless of the maternal interaction mode – singing or speech.

Conclusion – This study supports existing literature by showing that infants respond similarly to maternal singing and "motherese," highlighting an innate affinity for their mothers' emotionally expressive voices (Trehub, 2017; Trehub et al., 1997). The consistency of these findings, both in home and laboratory settings, suggests a universal infant response to maternal vocalisations, reinforcing the potential of both singing and speech in supporting infant development (Baker & MacKinley, 2006; de l'Etoile, 2006). Given the study's limited sample diversity, future research should broaden to include varied contexts and populations.

P2-J-433 - Raising helpful toddler training increased parenting self-efficacy in a small-scale randomized controlled trial

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Details

Raising Helpful Toddlers parent training (RHT) was designed to improve parent-toddler collaboration habits and strengthen family relationships. RHT is based upon strategies previously identified as common in many Indigenous-heritage families of the Americas - supporting toddlers' enthusiasm to contribute to family endeavors.[1-5] Recent evidence suggests its feasibility.[1] Here, we test RHT efficacy in a small randomized controlled trial including measures of general parent functioning with an active, attention-matched control. Research questions are whether RHT participation may predict changes in parenting self-efficacy (PSE), parent stress in general and regarding household chores, subthreshold depression symptoms, and mindful parenting.

Parents (n=61; 71.7% White, 10.0% Latiné, 8.3% Asian, 5.0% Bi- or Multiracial, 1.7% each of African American, Arabic, and African) of 12-48-month-olds, *M* age=2.3(.91), were randomized to parallel groups: RHT and active control, with a 1:1 allocation ratio. Median education was > Baccalaureate degree (US median: some college), median household income $90-110K USD (US median: $90,131).[6] Experimental and control groups did not differ at baseline on demographics, parenting stress, depression, or mindful parenting. Every participant met criteria for subthreshold depression (SD). RHT or a control training was presented via video conferencing (see Table 1 for content). Participants provided daily reports for 2 weeks, and completed quantitative questionnaires before and 2 weeks after RHT.

Results provide strong evidence that parent beliefs and practices targeted by RHT changed after RHT compared to the control training, from a series of linear models with primary and secondary outcomes as dependent variables. Compared to the control group, parents significantly increased (b=9.8988, $p<.001$) their: a) beliefs: toddlers are motivated and capable of helping, including them is worthwhile; and b) practices: supporting toddlers bids to help vs. redirecting, and rated that children participated more (b=1.43, $p<.001$). RHT participation predicted higher post-test PSE (b=0.85, $p=.003$), and mindful parenting trended toward a significant increase (b=3.00, $p=.053$). RHT participation did not predict any changes in post-test scores of parenting stress (b=-0.65, $p=.240$), depression symptoms (b=0.23, $p=0.840$), or chore stress (b=-1.2, $p=.124$).

The current work is a first step toward establishing a training to achieve multiple positive effects and pre-empt problems by encouraging parents to support their toddlers' enthusiasm to help in everyday interactions. Predominately middle class, highly-educated parents were motivated to change/maintain practices to align with values to raise a child who helps others, even in the context of subthreshold depression when they: a) recognized toddlers' abilities; and b) were given strategies for everyday actions. Positive results indicate that Indigenous strengths for learning can be beneficial beyond Indigenous families and communities. Better integration of Indigenous Knowledge Systems into developmental theory and research is suggested. Future work should include a full-scale trial with longitudinal follow-up using direct child observations in context and naturalistic helping paradigms. Promising mechanisms to explore in future work include disassociating PSE from parental depression symptoms.[7]

P2-J-434 - The influence of healthcare support and access to outdoor space on pregnancy-related anxiety and maternal prenatal attachment to the unborn baby during COVID-19 in England

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Details

Background: Persisting poor maternal mental health has been demonstrated to compromise the formation of maternal prenatal attachment to their unborn child[1–3], negatively influencing future parenting behaviours, including warmth and responsiveness to their infant[4,5] and consequently long-term attachment to the offspring[6,7]. Expectant parents typically experience greater healthcare needs, mental health concerns and economic considerations to support their transition to parenthood. The potential effect of governmental restrictions and available guidance with regard to the above mentioned factors during the COVID-19 pandemic have resulted in significantly lower levels of prenatal attachment to the infant being reported in several global populations[3,8]. How restrictions and guidance may have heightened feelings of anxiety, stress and depression as well as reduced an individual's capacity to form a bond with their unborn child remains relatively unexplored in the UK .

Aim: To explore the relationship between COVID-19 related anxiety, prenatal attachment to the unborn baby and how certain factors related to the UK 'stay-at-home' restrictions imposed by the government (on healthcare support and access to outdoor space) may have influenced this bond and heighted pregnancy specific anxiety during the pandemic.

Sample: From July 2020–April 2021, 2084 families were followed from pregnancy to 6-months postnatal. The current study considers a sub-sample of n = 250, participants who (1) resided in England, (2) were in their second or third trimester and (3) provided information related to their perception of healthcare support during pregnancy, access to outdoor space, financial stability, social support and two standardised questionnaires regarding their pregnancy-related anxiety (PRAQ) and attachment.

Findings: Hierarchical multiple regression analyses were used to explore the relationship between variables. In addition, social support and financial instability were explored as potential moderators within the model. Covariates (maternal age, household income and event related stress) did not have a significant association with pregnancy-related anxiety or attachment (p range = 0.12 - 0.840) but were included in all final models. There was no influence of perceived healthcare support and access to outdoor space on level of prenatal attachment, but a significant association with PRAQ-R scores was observed; (1) perceived healthcare support accounted for 9.9% of the variance ($p<0.001$) and (2) access to outdoor space accounted for an additional 6.6% ($p<0.001$). In total the final model accounted for 18.2% of the variance in PRAQ-R. Both lower perceived healthcare support and less access to outdoor space were associated with higher PRAQ scores. Social support and financial instability had no moderating effect on level of antenatal attachment or anxiety. Additional sub-analyses, exploring the influence of deprivation measured via participants postcode revealed no significant influence on the above-mentioned models.

Conclusion: To date this is the first study to explore the influence of governmental restrictions in England on expectant parents' pregnancy-related anxiety and attachment. Further analysis is now being undertaken of this data to explore the impact of variation in antenatal experiences, both on maternal mental health in the postpartum period, on maternal-infant attachment, and on subsequent maternal health and child development.

P2-J-435 - What can we learn from "Nelson, o nenê": contributions of developmental psychology to raising awareness about the importance of early childhood

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Details

The early years of life are important for human development, as "the acquisition of more complex skills in the future depends on more fundamental circuits that emerge in the first months and years of life" (FMCSV, 2017, p. 5). Thus, the present work aims to present the contributions of Developmental Psychology through specialized technical consulting to build a communication initiative that seeks to raise awareness in Brazilian society about the importance of early childhood.

The "Nelson, o nenê" project by the Maria Cecilia Souto Vidigal Foundation involves creating a character, a baby, and his family responsible for propagating scientific knowledge in a simplified manner on social media about the importance of early childhood. This project was idealized based on studies showing a lack of knowledge among part of the population regarding important processes involving child development, especially those occurring in early childhood. In a study conducted in 2020, about 42% of respondents had no idea when the learning process in children began, demonstrating a knowledge misalignment with scientific knowledge (FMCSV, 2020). Therefore, since 2019, "Nelson, o nenê" has been democratizing access to scientific information about child development for the Brazilian population, especially for parents and caregivers of children up to three years old.

The project seems to fulfill its purpose, as in October 2023 alone, the social media posts of "Nelson, o nenê" reached over 1 million people. High performance on social media occurs mainly among women, mothers, self-declared Black individuals, from social classes C, D, and E, as shown by 2021 data about the project's audience. Thus, the reach of posts and follower feedback on social media demonstrate the importance of initiatives like these in ensuring the comprehensive protection of children.

To implement the project, the foundation relies on a team of experts who provide consulting on various issues. In the case of Developmental Psychology, the topics covered include the impact of racism in early childhood, specific aspects of attention and care for children and families in situations of social vulnerability, as well as the importance of taking care of those who care for children, especially mothers."Nelson, o nenê" in addition to providing data on aspects of child development, promotes interdisciplinary dialogue through collaborative actions with experts addressing topics such as the importance of reading and proper child nutrition, as well as the right to daycare. These are many relevant themes translated into a simple, fun, and light language that makes scientific concepts and complex topics, derived from recent scientific research, accessible to all followers.

Thus, the partnership between the University and the Foundation, through the consultancy project in the areas of Developmental Psychology, illustrates an important knowledge transfer action to contribute to the visibility of the importance of early childhood.

P2-J-436 - Comparing longitudinally full- and pre-term neonates'/infants' heart rate variability between rest state and spontaneous interactions with their parents

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Details

Objective of the study: HRV is widely used to efficiently assess the regulatory activity of the autonomic nervous system (ANS) by its sympathetic and parasympathetic components. HRV analysis gives paramount hints about the newborns' wellbeing and socioemotional and cognitive development. The ANS undergoes significant maturation between 31- and 38-weeks' gestation. Prematurity delays maturation of HRV and preterm birth has been associated with decreased HRV. Lower HRV values

indicate abnormal adaptation with impaired function of the ANS and vulnerability to stress, while an increase in HRV represents physical and mental adaptability along with efficient autonomic mechanisms.

Environmental challenges in the postnatal days play a crucial role in the development of parasympathetic system and maturational course of sympathetic regulation may be altered by physiological challenges in the Neonatal Intensive Care Unit (NICU). Preterm infants in NICU experience chronic exposure to stressors. Preterm neonates show decreased Heart Rate Variability (HRV) compared to full-terms. The following research questions were examined: (a) Are there differences and similarities in HRV metrics of full-terms and pre-terms from neonate/infant rest state to neonate/infant-parent spontaneous naturalistic interaction? (b) Do HRV metrics of full-term and pre-term infants from rest state to spontaneous naturalistic interaction of the neonate/infant with the parent differ when compared longitudinally across the first year of life (0-12 months).

Methodology: Short-term recordings of HRV parameters (time and frequency-domain indices and non-linear measurements) of 28 premature healthy neonates were compared with metrics of 18 full-terms. HRV recordings were performed at home at term-equivalent age from neonate/infant rest state (TI1) to neonate/infant interaction with the parent (TI2) at 6 age levels across the first year of life, that is, at birth and at 2, 4, 6, 9 and 12 months.

Results: Results from HRV analysis of the neonatal period showed that between TI1 and TI2, heart rate and total power increased while a2 decreased for both full-terms and preterms. Very Low Frequency (VLF) peak decreased for full-terms and VLF (%) increased for preterms. These imply a common coactivation of sympathetic and parasympathetic systems for both preterm and full-term neonates and an additional increase of the parasympathetic function for preterms. Analysis of neonate/infant HRV metrics longitudinally is in progress and it will be completed by May 2024.

Conclusions: Premature neonate-parent spontaneous interaction may reinforce neonates' autonomic nervous system maturation. The findings of this study may have implications for interventions to reduce the adverse environmental impacts on preterms' autonomic nervous system development, to mitigate exposure to stressors in NICUs and to enhance maturation of the autonomic nervous system of preterm neonates.

P2-J-437 - Developmentally Supportive Interactions: PICCOLO as a tool for intervention with families with young children at risk of Autism Spectrum Disorder

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Details

INTRODUCTION

Developmentally Supportive Interactions (DSI) are crucial for infants and toddlers' development (Innocenti et al., 2013; Provenzi et al., 2021), being especially critical for children with a disability, such

Autism Spectrum Disorder (ASD) (Tomeny et al., 2020). Video feedback has proved to be a good tool to improve DSI and the infant's development (Borelli et al, 2019, O´Hara, 2019, Olhaberry et al., 2019). Intervenors working with families are moving from more directive and instructional models of feedback to more collaborative and reflective ones, introducing coaching strategies (e.g., highlight caregiver's strengths, active listening, guide for self-reflection) (Allen & Huff, 2014; Innocenti et al., 2023; Rush et al., 2003). There is strong evidence that feedback introducing coaching strategies is effective at enhancing DSI (Artman-Meeker et al., 2015; Powell & Diamond, 2013).

AIM OF STUDY

We aimed to design and assess the efficacy of a video feedback intervention based on the PICCOLO (Roggman et al., 2013; Vilaseca et al., 2021) for improving DSI in families with a young child at risk of ASD.

MATERIAL & METHODS

Participants were 10 primary caregivers (8 mothers and 2 fathers) and their 10 children aged 24-36 months. Families had adequate internet access and were recruited from Early Intervention Centers in Spain. Inclusion criteria: a) Child at medium-high risk of ASD; scores >=8 in M-CHAT-R (Robins et al., 2009); b) Primary caregiver at risk of anxiety, depression, or parental stress; scores >=7 in the anxiety or the depression dimensions of HADS (Caro & Ibañez, 1992; Zigmond & Snaith, 1983), or scores >= 86 in the stress dimension of the PSI-F (Abidin, 1995; Diaz-Herrero et al., 2010); c) Primary caregiver with a low or medium-low level of DSI (scores <=40 in the PICCOLO. The PICCOLO is an observational tool aimed to assess parental interactions with young children (10-47 months of age). It includes 29 items each of which refer to a developmentally supportive parenting behavior, organized in 4 subscales (Affection, Responsiveness, Encouragement, and Teaching). Every subscale includes 7 items, except Teaching, which has 8.

Twelve bi-weekly sessions of approximately 90 minutes were conducted for 6 months, by videoconference with every caregiver. Every session included reflective video feedback, using coaching strategies, about three different developmentally supportive parenting behaviors previously identified in self-recorded caregiver-child interaction during play at home. Caregivers were asked to monthly self-record a session lasting between 8 and 10 minutes playing with their child at home, and with their own toys, following the instruction "Interact and play with your child as you normally do". Some games and materials, as books, toy animals, toy kitchens, dolls, building blocks, etc., were suggested in a brief guide containing basic recommendations for video recording. Throughout the 12 sessions, the 29 different developmentally supportive behaviors included in the PICCOLO were introduced.

RESULTS

Our results showed an improvement on DSI in all the PICCOLO dimensions, comparing pre and post-intervention scores.

CONCLUSIONS

Our results provide new data supporting the effectiveness of interventions based on the PICCOLO and reflective video feedback to increase DSI.

Poster Session 03

P3-A-438 - How general is affordance perception? Infants walking over slopes and bridges

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Details

An affordance is the fit between body and environment that makes particular actions possible. Functional motor behavior requires perception of affordances—for example, whether a slope is too steep or a bridge too narrow for walking. Prior work shows that newly walking infants attempt to walk down impossibly steep slopes and over impossibly narrow bridges. Over months of walking experience, infants' perception of affordances becomes increasingly accurate in both tasks. However, prior work did not *test the same infants in both tasks*, so the extent to which perception of affordances generalizes across tasks is unknown.

To test whether perception of affordances generalizes across tasks, we tested the same infants walking down slopes (0–50°) and over bridges (4–60 cm); Figure 1. Here, we report preliminary data from 15 13-month-old novice walkers (*M* = 1.0 month of walking experience) and 22 18-month-old experienced walkers (*M* = 6.4 months of walking experience). We used a rigorous psychophysical procedure to determine each infant's "threshold" in each task (steepest slope and narrowest bridge infant walked successfully on 50% of trials). To compare perception of affordances across tasks with different biomechanical constraints and metrics (i.e., degrees vs. centimeters), we used previously collected data to create a pooled success function and calculated the pooled standard deviation for slopes (*SD* = 3.59°) and bridges (*SD* = 3.93 cm). We normalized each increment in the current experiment by the pooled SD and binned trials by SDs to equate affordances—that is, possibilities for walking—across tasks.

Replicating prior work, novice walkers had shallower thresholds for slopes (*M* = 9.6°) than experienced walkers (*M* = 22.8°) and wider thresholds for bridges (*M* = 27.0 cm) than experienced walkers (*M* = 15.8 cm). Attempts to walk decreased with SD bin on both slopes (Figure 2A) and bridges (Figure 2B), but novice walkers erred more on impossible increments than experienced walkers, with interactions between group and bin for slopes (Wald X^2 = 36.64, $p < .001$) and bridges (Wald X^2 = 18.76, $p = .005$).

Most important was whether infants' perception of affordances generalizes across slopes and bridges (Figure 2C-D). For both novice and experienced infants, perception was equally accurate between slopes and bridges at the most impossible increments. However, for novice infants, we found only main effects for SD bin and task (Wald X^2s ≥ 13.62, ps < .001) and no interaction; posthocs revealed differences in attempt rates for possible SD bins (ps ≤ .048) but no differences for bins 2 SDs and 3 SDs beyond threshold (ps ≥ .27). For experienced infants, we found an interaction between task and bin (Wald X^2 = 16.50, $p = .011$), but posthocs indicated the interaction was driven by differences at 1 SD and 2 SDs easier than threshold (ps ≤ .045).

Preliminary results suggest that affordance perception generalizes for both new and experienced walkers for impossible increments well beyond their ability. Affordance perception for ambiguous and possible increments shows more protracted development.

P3-A-439 - The transition to manual reaching elicits changes in infant-looking behaviors

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Details

The acquisition of motor skills, particularly the ability to reach towards objects, is a critical milestone in human development, enabling individuals to perform complex behaviors integral to daily activities. This study investigated whether infants' looking behavior changed in relation to the emergence of reaching. While early theories stressed the primary role of vision for the guidance of the arm movement towards the object target, here we ask whether visual attention directed at the object target changes after infants successfully contact the target with their hand. One assumption of early theories was that infants had an object-directed "goal" which was the basis for developing visually-guided reaching toward the object. Here instead, we make the assumption that the "goal" of reaching only forms as an emergent property of infants' initial attempts to reach for the object. If that is the case, then, we should observe a change in visual attention to the target between the pre- and the post-reaching period as a result of goal formation following reaching onset.

Building on this insight, our study longitudinally examined the looking behavior of infants presented with a target in relation to the emergence of reaching. Eight infants were followed weekly over a 11-week period around the transition to reaching (5 weeks before reach onset, the week of reaching onset, and 5 weeks after reach onset). Infants were supported in an infant seat and presented with objects of varied shapes within a pre-calibrated eye-tracking area for 5 seconds, such that we could identify where infants were directing their visual attention on the object prior to bringing it in their reaching space.

Preliminary results from 5 infants presented with a drumstick-shaped object revealed that infants' fixation durations on the object were mainly distributed between the center and the drum of the object over the 5 weeks prior to reach onset. Following reach onset, infants' fixations

durations began to focus increasingly more toward the drum area of the object, while fixations durations to the handle of the drumstick declined indicating a change in visually-directed attention.

This study sheds light on the interactive relationship between vision and motor skills during the crucial period of reaching development. These findings suggest that infants' vision and goal formation may be influenced by the emergence of motor skills and how skills develop over time. Goal formation in early development may initially be viewed as a bottom-up process forming from infants' direct interactions with their surroundings rather than a top-down process where the mind is directing the purpose of the action. Eventually, as infants are becoming more skilled, vision may take a more predominant role facilitating the planning and execution of the goal-directed action.

P3-A-440 - On the move and curious: Examining the impact of transitions in motor development on infants' sustained attention to faces of different races

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Details

During the second half of the first year, infants undergo a variety of motor and cognitive changes. For example, infants typically begin crawling during this period. Additionally, they show a decline in visual preferences for familiar race faces (e.g. Fassbender et al., 2016). Given the importance of determining how to act in new contexts with novel people, infants might increase their attention toward unfamiliar face types. Sustained attention (decelerated heart rate) has been used as an indicator of active cognitive processing in infants (Richards, 1987) and may yield a more precise understanding of infant looking behavior. Therefore, in this study we assessed whether crawling ability, infant age, or both better predicted infants' sustained attention when viewing familiar and unfamiliar race faces.

We collected data from 194 (98 female) infants aged 5.5 to 10.5 months. Parents reported their infants' daily facial experiences and completed a motor development checklist in the week prior to testing. During the study, infants saw four female-male face pairs (two Black, two White) with neutral (n = 89) or pleasant expressions (n = 105). To assess infants' sustained attention, we recorded their heart rate and audited each infant's data using procedures established by Colombo et al. (2001). We calculated the percent of time in sustained attention while infants looked at each face pair using the inter-trial interval that preceded the trial as the baseline comparison.

We compared three models with the following predictors, 1) age group, 2) crawling ability, 3) age group and crawling ability to assess differences in infants' sustained attention when looking at different race faces. In all analyses, face race and posed expression were included as predictors and infants' percent experience with Black female and male faces and White female and male faces were covariates. We compared Akaikes' Information Criterion Corrected (AICC) for each model with lower AICC indicating a better fit to the data (Glatting et al., 2007).

The crawling ability model provided the best fit to the data. In the neutral condition there was a significant crawling ability x face race interaction $F(2, 86) = 5.50$, $p = .006$, Cohen's $f = .32$. Not crawling infants who viewed Black face pairs had higher percentage of sustained attention compared to when they viewed White face pairs, $t(86) = 2.78$, $p = .007$, and compared to transition to crawling infants who viewed Black face pairs, $t(86) = 2.99$, $p = .004$ (see Figure 1). The percent of facial experience with Black males covariate was significant, $F(1, 82) = 10.88$, $p = .001$, Cohen's $f = .34$. Percent of Black male facial experience negatively correlated with percent sustained attention, $r = -.13$, $p = .017$. In the pleasant condition, results showed a main effect of face race, $F(1, 102) = 8.86$, $p = .004$, Cohen's $f = .27$. Infants' percentage of sustained attention toward Black face pairs was significantly higher than that toward White face pairs (see Figure 2).

Infants in both conditions showed greater sustained attention to unfamiliar race faces. Moreover, less real-world experience with Black individuals was positively related to more sustained attention toward Black faces. In the neutral condition only infants who were not crawling showed greater sustained attention to Black faces. It is possible that transitions in motor development might temporarily disrupt active processing to novel stimuli while infants are learning a new skill. Our results add to a growing body of evidence that suggests changes in infants' motor skills influence what they attend to in their social environment.

Back to top

P3-A-441 - The development of the visuo-tactile temporal binding window in the first year of life

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Details

Previous studies have shown that audio-visual temporal binding windows decrease in duration from infancy to adulthood. But this developmental trend may not be seen across all sense pairings (e.g., due to differences in the biomaturational constraints across sensory modalities). Here we are investigating whether there are developmental changes in visuo-tactile temporal binding between 4 and 10 months of age concerning visual and vibrotactile stimuli presented on infants' feet. This age range was chosen as infants typically develop object-directed reaching behaviour (which leads to visuo-tactile experience) during this developmental period. Therefore, a short reaching task will also be carried out to explore potential connections between object-directed reaching ability and infants' visuo-tactile temporal binding.

In the initial version of this study, infants (22 male, 3 female, aged 111-289 days) were first habituated to vibrotactile and visual stimuli presented simultaneously. Stimuli were presented for 700 milliseconds on alternating feet with an interstimulus interval of 1500 milliseconds. Trials continued until the infant looked away for 2 continuous seconds. Once an infant had reached habituation criterion (50% less total looking across the most recent 3 trials than in the first 3 trials), they were presented with four test trials: the familiar synchronous trial and three asynchronous trials (where the light's onset was delayed by 100ms, 250ms, and 400ms respectively) (see Figure 1). The order of these four test trials was counterbalanced across infants. Infants' total looking times in each test trial were recorded and reaching ability was coded and quantified. Preliminary findings from the initial study of 25 participants (see Figure 2) suggest a trend for differentiation of the synchronous condition from the 100 ms and 250 ms conditions. Therefore, a follow-up study is currently being carried out using the same procedure described above with the following visual delays: 50ms, 100ms, and 250ms.

In the initial analysis of the first study, we split infants into two age groups – those above 6 months and those below. Through this we discovered that the greatest differentiation between the various asynchronous conditions and the synchronous visuo-tactile stimulus onset differed between these groups; with younger infants' greatest differentiation to the synchronous condition being with the 250ms delay and older infants' being with the 100ms delay (see Figure 2). This may suggest a progressive narrowing of the visuo-tactile temporal binding window across the first year of life. Therefore, in the current study, we decided to recruit infants aged 4 and 10 months to evaluate this potential age effect further.

Following this next study, we intend to explore infant visuo-tactile temporal binding windows using other methods, including fNIRS and in the context of an infant virtual reality environment (BabyMIRAGE), where proprioceptive and visual cues to limb position can also be manipulated to determine the role of these cues in temporal binding of multisensory cues to the body across infancy.

P3-A-442 - The impact of affordances in the home environment on reaching skills in pre-crawling infants

Emma Costello [1], **Melanie Tommer** [2], **Aleena Purewal** [1], **Melanie Shultz** [1], **Chloe Warham** [1], **Katrina Butcher** [1], **Sarah Berger** [3], **Lizbet Rodriguez** [4], **Michele Maia** [5], **Regina Harbourne** [1]

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Details

Title

THE IMPACT OF AFFORDANCES IN THE HOME ENVIRONMENT on REACHING SKILLS IN PRE-CRAWLING INFANTS

Infants begin to reach more accurately towards objects between 4-5 months of age. The early ability to reach and explore objects even at 5 months of age has been linked to greater academic success in later years (Bornstein et al, 2013), indicating that early reaching skill may be a potential factor in learning over time. Additionally, we know that motor skills such as reaching are environmentally linked, with greater opportunities for movement supporting greater skill (Clearfield et al, 2014). The Affordances in the Home Environment for Motor Development-Infant Survey (AHEMD-IS) (Caçola et al, 2015), is a caregiver survey that quantifies movement opportunities in the home environment including physical space, variety of stimulation, and toys. As part of a larger study examining pre-crawling infants abilities during the A-not B task within the home, we questioned whether home affordances influenced differences in the ability of infants to reach efficiently (Fig1.). Our purpose was to characterize reaching and sitting postural control that supports reaching as related to the overall A-not-B task, and the effect of home affordances for movement.

We recruited 23 infants, 12 females, M_{age}= 232 days (SD=20), via public announcements in Brooklyn NY and Pittsburgh PA. All infants could sit independently but were not crawling and were typically developing.

Data was collected via video in the home for later analysis. Infants reached for toys that appeared through an aperture in a reaching board in the A or B location (Figure 1). Infants sat on a cushion to slightly challenge newly achieved sitting skills. For this study we used the second reach to the A location to reduce the likelihood of delays related to finding the toy at the B location. Datavyu video coding software was used to determine onset and offset of reach and balance errors. Balance errors included falling, high guard, and leaning during the reach. AHEMD-IS was filled out via an online form during the

visit by the parent and later scored for 1) variety of gross motor opportunities, and 2) number of toys for infants.

Bivariate correlations revealed a significant relationship only between reach duration and balance errors: $r(21)= .369$ (p=0.042), with no significant relationships between reach duration and either of the AHEMD variables. Multiple linear regression was utilized to determine the proportion of variance in reach duration that might be explained by age and errors. Only errors contributed significantly, $R^2=.25$, $F(2,21)= 4.42$, $p=.02$. Thus, infants who made more balance errors had longer reach times regardless of age or environmental affordances as measured by the AHEMD-IS (Figure 2).

At this early age, the affordances in the environment may be less important than later in development as infants become mobile. However, balance control in the infants' newly achieved upright orientation of sitting, appears to impact the ability of infants to reach efficiently and explore objects in the near environment. Other factors measured during this task, like speed of eye-tracking between locations, will further elucidate motor factors important to success in the A-not-B task.

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P3-A-443 - Relationship between complementary feeding approaches and child development in the first two years of life: a longitudinal study

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Details

The introduction of solid foods into infants' diet is a crucial phase for their development. In recent years, an increasing attention has been raised about the impact on child health of baby led - weaning (BLW), a way of introducing solids alternative to feeding infants puréed foods on a spoon. Although it has been hypothesized that there is a positive relationship between baby-led weaning and psychomotor development, this aspect has not been yet investigated.
We carried out a longitudinal study on a sample of 194 infants at the beginning of the study, which were tested at 4, 8, 12, 18 and 24 months of age. Mothers were asked to fill out questionnaires about their infants' psychomotor development (Developmental Profile-3 – DP-3; Alpern 2007) and, starting at 8 months of age, about the type of complementary feeding approach and meal habits of their child. We also collected data about infants' pacifier use, day care attendance and sociodemographic aspects, as control variables. Additionally, we observed a typical meal for each participant, from which we scored the proportion of self-feeding (i.e., the number of episodes in which the infant ate independently

divided by the total number of feeding episodes, including spoon feeding and independent feeding). Concurrent and longitudinal regression analysis were run.
Results showed that infants who were exposed to BLW at 8 months of age obtained higher scores on the DP-3 Adaptive Behaviors Scale at 12 (t=4.322, p<0.001) and 24 months (t=2.388 z=0.018). In addition, infants who sat more often with their family during the meal at 8 months, obtained higher scores on the DP-3 Adaptive Behaviors Scale at 8 (t=3.890, p<0.001) and 18 months (t=2.078, p=0.039) and on the DP-3 Cognitive Scale (t=2.573, p=0.011) at 8 months. Likewise, children who sat more with their family at 12 months obtained higher scores on the Adaptive Behaviors Scale at 24 months (t=3.595, p<0.001). Moreover, there was a positive relationship between the proportion of self-feeding scored during the meal (i) at 8 months and the scores in the DP-3 Motor Scale at the same age (t=1.997, p=0.047), (ii) at 12 months and the scores on the DP-3 Adaptive Behaviors scale at 18 months (t=2.069, p = 0.040), (iii) at 18 months and the scores of the DP-3 Adaptive Behaviors Scale at the same age (t=2.390, p=0.018) and at 24 months (t=2.330, p=0.021), (iv) at 24 months and the scores of the DP-3 Adaptive Behaviors Scale at the same age (t=2.653, p=0.009). In conclusion, we found both concurrent and longitudinal significant relationships between a baby-led complementary feeding approach and several aspects of children's development, mainly adaptive behaviors and cognitive skills. As at 4 months of age (i.e., before the onset of complementary feeding), DP-3 scores did not significantly differ between groups of infants which were exposed to different complementary feeding approaches (i.e., traditional, baby-led, or mixed) at 8 months of age, a baby-led complementary feeding approach seems to booster important skills during infant development.

P3-A-444 - A translational investigation: From qualitative clinical assessments to a quantitative coding scheme of infant general movements

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Details

A critical healthcare challenge is the early identification of life-long neurodevelopmental disorders (NDD). Infant general movements (GMs)—an early spontaneous movement pattern observed from birth until around 5 months of age—have been increasingly associated with subsequent social-communication (SC) abilities. Abnormal GMs have negative cascading effects on a wide array of cognitive domains. Therefore, the general movement assessment (GMA) has been globally recognized as one of the best clinical tools to predict NDD outcomes; it is a reliable, non-invasive, and highly sensitive method for evaluating the *quality* of the young nervous system, rooted in the complexity and variability of the motor repertoire. However, this observational protocol is neither quantitative nor allows for high-frequency longitudinal tracking of infant motor trajectories. Furthermore, it requires assessment from a qualified individual who has undergone extensive training. Understanding early developmental trajectories that highlight windows of interaction, change and plasticity requires high-frequency behavioural sampling using a sensitive, validated tool. Monitoring infant GMs from birth provides a unique opportunity to understand how motor and cognitive development operate as a dynamic and intertwined system, thereby leading to neuro-typical and neurodiverse outcomes.

This study aimed to translate the clinical qualitative GMA into *objective quantitative* measures that can be used widely without the need for clinical qualification. Consistent with the clinical assessment, our novel behavioural coding scheme captures the *complexity* and *variability* of infant GMs using Datavyu coding software and home recorded infant videos. The coding method isolates specific limb and joint movements and then combines these to arrive at a nuanced, holistic, and quantitative picture of movement quality. Our approach was tested in a translational project in which researchers with no prior GMA expertise video-coded a restricted set of motor actions in the wrists, ankles, hips, and shoulders in a sample of infants (n = 30) at low- and high-risk of NDDs over the first 3 months of their life. We tested the reliability of our coding scheme across coders and its validity by assessing the same infants in the standard clinical GMA. Our findings showcase high inter-rater reliability and high consistency with the GMA clinical assessment across infants. Taken together, our approach has the potential to revolutionize GM assessments by using an alternative that can (1) be adopted by non-experts via free, opensource applications; (2) is able to capture the clinical assessment successfully and (3) is able to make accurate predictions about developmental outcomes.

P3-A-445 - How early motor system development promotes spatial navigation - an infant MRI study

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Details

Infants' early motor development has profound consequences on perception in infants, including action understanding, mental rotation, and proprioception. First studies indicate that the transition from crawling to walking may also have critical influences on spatial navigation. However, the research on infants' early spatial navigation remains scarce and the neural correlates underlying this developmental change around the end of the first year of life have not yet been investigated.

The present study employs a multi-methodological approach integrating motor development tasks, sleep MRI scans and a behavioral spatial navigational task to address this knowledge gap. Specifically, at 12 months of age (final N=30), fine and gross motor capacities were tested using age-specific tasks from Bayley's scale. This included testing infants' crawling and walking abilities along with hand and finger grasps. Spatial navigation skills were tested with a "hide-n-seek" task inspired by the Morris water maze including proximal and distal cues. In a separate MRI session, infant brain scans were collected. The brain scans were segmented using a standard infant brain parcellation atlas, focusing on specific regions of interests (ROIs) involved in spatial navigation: primary motor areas, premotor areas, supplementary motor areas, anterior hippocampus and parieto-insular vestibular cortex.

I will present results with regards to the hypothesis that the motor capacities of infants at 12 months affect their abilities to find a goal location by successful spatial navigation and that this effect is mediated by increased volumes in brain regions associated with spatial navigation, i.e, sensorimotor cortex, hippocampus and vestibular cortex, and the connectivity between those regions (aggregated into a motor system maturity score).

This study will be the first to investigate a link between infants' motor skills and early spatial navigation and provide a better understanding of the neural underpinnings of motor system development and its consequences on the domain of spatial cognition.

P3-A-446 - Infants motor system responses to beat structure in musical rhythms

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Details

When we hear auditory sequences with a temporal beat structure (e.g., musical rhythms) we tend to sense a steady beat, to which we synchronize our movements. Beat perception and synchronization are universal in humans and essential for music, but the developmental trajectory of their underlying neural mechanisms remains unclear. While the supplementary motor area (SMA) in adults responds more to auditory stimuli that elicit a sense of beat, it is not clear if the infant brain's motor system responds similarly. Beat synchronization ability only develops around 3–5 years of age although infants move spontaneously more for beat-based rhythms compared to other auditory sequences. Thus, if SMA activity reflects beat perception and the affordance of synchronization, it should not be more active during infant perception of beat-based rhythms compared to rhythms without a beat, whereas if SMA activity reflects general motor system engagement or the motivation to move, it should respond more for beat-based rhythms than rhythms without a beat.

We used functional near-infrared spectroscopy (fNIRS), a non-invasive imaging tool, to measure localized SMA activity in 72 infants (6-15-month-olds) as they listened to audio stimuli that differed in temporal structure (Beat and Non-Beat conditions) and loudness (Loud and Quiet conditions). Each trial consisted of a 15-second auditory rhythm followed by a 15-second baseline period without sound. During the trials, participants watched images of three randomly selected visual categories on the screen (e.g., cat, dog, and book). We varied the timbre and pitch of the sounds in different trials to maintain infants' interest in the stimuli. The 4 conditions (2 Beat by 2 Loudness) were presented randomly in blocks of 4 trials. The study would terminate when participants completed 36 trials or when they became fussy. The number of completed trials ranged from 5–36 (average = 29 trials).

We used HITACHI ETG 4000 fNIRS (10 Hz) to measure the localized changes in oxy- and deoxy-hemoglobin concentrations, indicative of neural activity, around the SMA and auditory cortices in bilateral Temporal lobes. These brain regions for each participant were determined based on reference points in the 10-20 system (e.g., Cz).

Preliminary data analysis (n=16) revealed an increased oxyhemoglobin concentration (indicating increased neural activity) in the SMA during the Beat condition compared to the Non-Beat condition (**Figure 1**)**.** Interestingly, an increased oxy-hemoglobin concentration was seen in Temporal lobe channels for Quiet stimuli in the Beat condition compared to the Non-Beat condition (**Figure 2**)**.** This finding may suggest that SMA's sensitivity to beats augments stimulus prediction in a condition where sensory input was weak, resulting in increased activity in the auditory cortex.

We are currently processing the data from the remaining participants. Meanwhile, we are recording infants' attention to Beat and Non-Beat stimuli using a preferential-looking paradigm to gauge their preference for beat structure in rhythms. We surveyed infants' linguistic background and musical experiences to understand their impact on the development of neural responses to rhythms. In conclusion, our preliminary results provide insights into the neural mechanisms underlying infants' rhythm perception, highlighting the role of SMA in beat perception and its influence on the perception of low-level acoustic features like loudness.

P3-A-447 - Mapping between self and world: An experimental manipulation of infants' hand posture influences looking at goals of adult reaches

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Details

The ability to infer the goal of other people's actions is a crucial step in infants' social cognitive development. Previous research has demonstrated the correspondence between infants' motor experience and their perception of others' goals. For example, the ability to infer the target of an actor's reach based on the shape of their grasping hand differs between 6-month-olds who can already perform grips using thumb opposition, and those who cannot (Daum et al., 2011). A fundamental mapping between perception and production in early development could allow infants to use self-experience to parse the visual scene. In parallel, infants with more experience of performing a specific action will also likely have more visual experience from observing their own performance.

One means of disentangling the relative contributions of visual experiences versus motor experiences is to introduce an experimental manipulation that inhibits infants' ability to use their motor experience during action perception. In the present study, we do this by tethering the infant's thumb, index and middle fingers together, preventing them from putting their hands in a thumb-opposite grasping posture. If infants use representations of the self in inferring the meaning and goals of others, this physical intervention should influence the inferences they draw about other people's actions.

In a preliminary laboratory study using a within-subjects design, 15 12-month-olds (mean age 371 days, *SD*=7.9 days) observed an actor reach for one of two objects (large or small) using two different hand shapes—a power (whole-hand) or precision (thumb-to-finger) grasping posture. At 12 months, most infants will have produced and used thumb-to-finger grips. We therefore hypothesized that when their hands were free, they would be able to distinguish between the grasp types; but when restricted, making this distinction would become more difficult. To prevent the use of spatial-path trajectory cues to infer the actor's goal, the small and large objects were placed at the end of a tunnel, and the infants' looking data were only analysed up to the point at which the actor's hand emerged from the end of the tunnel and moved left or right to grasp the target object. Looking time at each of the objects was recorded.

Data were analysed using a linear mixed effects model with factors of look direction (to congruent or incongruent object) and infant hand manipulation (hands free or restricted), and their 2-by-2 interaction. Results showed that infants looked significantly longer at the congruent than the incongruent

object (B = 288.65, *SE* = 208.82, *p* = 0.01). A congruence-by-infant hand manipulation interaction indicated that looking time to the congruent object significantly fell when the hands were restricted (B = -341.21, *SE* = 155.03, *p* = 0.03; Figure 1). These results suggest that at some level of analysis, infants use motor representations to infer the goal of another person's reaching towards objects, and that the link between action perception and production in infancy may not be based purely on visual experience. A replication will be conducted in a new, larger sample and presented at the conference.

P3-A-448 - Copy me, copy you: Investigating the development of facial mimicry in infancy

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Details

Facial mimicry, the tendency to spontaneously and unconsciously copy others' facial expressions, plays an important role in social interactions, yet its ontogeny is still debated. I will present the results of two studies that test the hypothesis that sensorimotor experience is critical in the development of facial mimicry. The first study showed a relationship between mothers' tendency to imitate their 4-month-olds' facial expressions during a parent-child interaction session and the infants' tendency to mimic others as measured by electromyography (EMG). Maternal facial imitation was not related to infants' mimicry of hand actions, and instead we found preliminary evidence that infants' tendency to look at their own hands may be related to their tendency to mimic hand actions. However, because this was a correlational study in which infants' sensorimotor experience was not manipulated, it does not provide conclusive evidence for the idea that correlated sensorimotor experience plays a causal role in supporting mimicry. Additionally, as this study did not measure motor cortex activation, it is unknown how the observed facial mimicry related to activation of the corresponding motor representations in the brain. In the second preregistered study (link to preregistration: https://tinyurl.com/w75f8xxk) we are systematically manipulating infants' experience with their own facial actions by giving 4-month-olds two weeks of daily sensorimotor experience with their own facial actions via a toy mirror, while infants in the control condition play with the same toy without the mirror (see Figure 1). Before and after this intervention, we measure infants' facial mimicry using EMG and their sensorimotor cortex activation using electroencephalography (EEG) while they observe videos of other infants' facial actions. We predict that infants who receive a greater amount of correlated sensorimotor experience with their own facial actions will show greater sensorimotor cortex activation and greater facial mimicry during the observation of others' facial actions. Data collection for this study is nearly finalised (N=98 participants tested so far), and the final results will be presented at the conference. The use of complementary methods (EMG and EMG) allows us to obtain an objective measure of facial mimicry (EMG), as well as a measure of the neural correlates underlying it (EEG). Together these studies provide insight into the role of correlated sensorimotor experience in the development of facial mimicry, contributing to the ongoing debate regarding its ontogeny.

P3-A-449 - Examining the role of parental resetting during the development of early reaching skills

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Details

Background: The acquisition of motor skills during infancy can have profound cascading impacts throughout an individual's development (Adolph and Hoch, 2019). Reaching, for example, is one of the earliest emerging skills and has been shown to impact infants' perception about themselves, their actions, and their agency (Sommerville et al., 2005; White et al., 1964). Parent-infant interactions are critical for healthy development, and parents may encourage reaching development during interactions by scaffolding their infant's reaching. However, the importance of parent-infant interactions for reaching development remains unclear. Some argue that mainly haptic experiences encourage reaching (van den Berg & Gredeback, 2021), while others suggest that the social parent-infant interaction enhances learning opportunities (Libertus & Needham, 2010). The current study examines the impact of task resetting – a non-haptic social exchange – on infants' reaching skill development.

Methods: 84 parent-infant dyads were observed weekly for 8 weeks starting around 3.5 months of age. Observations were completed remotely and included a 1-minute reaching task each week. In a follow-up at 10 months of age, parents also completed the Early Motor Questionnaire (EMQ; Libertus & Landa, 2013). Using offline coding, trained observers quantified parents' engagement in resetting behaviors, the child's latency to first object contact, and the child's object exploration strategy. Parents were divided into "high" and "low" resetting tendencies based on cluster analysis.

Results: Infants in the high resetting group showed a significantly shorter latency to contact than infants in the low resetting group across visits 1-4, $t(82) = 3.92$, $p < .001$, and across visits 5-8, $t(82) = 2.84$, $p = .006$ (see Figure 1). Further, infants in the high resetting group showed faster growth in simple touching proportion than infants in the low resetting group, but only across visits 1-4, $t(82) = -2.22$, $p = .029$ (see Figure 2). For the 10-month follow-up visits, ANCOVA results revealed a significant main effect of Resetting Group for infants' fine motor scores, $F(1, 59) = 6.92$, $p = .011$, $\eta 2 = .102$, and perception-action scores, $F(1, 59) = 5.12$, $p = .027$, $\eta 2 = .075$, such that scores in both domains were significantly higher for infants in the high resetting group.

Implications: The current study confirms that parental resetting behavior may encourage the development of reaching skills during early infancy. Further, our results suggest that resetting behaviors may provide a new avenue for designing parent-guided interventions targeting reaching skills. Many parents worry about their child's motor development (Porter & Ispa, 2013). Therefore, offering simple and low-cost activities such as resetting may both promote reaching skills (as observed here) and simultaneously put anxious parents at ease about their child's early motor development.

P3-A-450 - Imitation Learning in Infancy

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Details

Human life is characterised by imitation. We copy those around us constantly, both consciously and unconsciously, to connect with others and to learn from them. Imitation is so prevalent in human behaviour that some have labelled us *Homo Imitans*. Embedded in this label is the assumption that imitation is part of our nature—an innate capacity that defines our species. Yet the developmental status of imitation is one of the most enduring controversies of modern psychology: Is imitation an innate ability, or is it a skill earned early in life? Indeed, based on behavioural observations, imitation is clearly evident in the second half of the first year of life. However, the developmental trajectory of imitation is still hotly debated. For example, the associative sequence learning model argues that the developmental trajectory of imitation is linear and learned through repeated, coincident experience of producing and perceiving specific body gestures, while the innate mirroring model argues that the developmental trajectory of this phenomenon is non-linear, with neonatal imitation dropping off after the second month of life due to a maturing motor cortex replacing early imitative responses with social smiling and vocalisations. As such, for the first time ever, this study aims to resolve this long-standing controversy by combining the highly sensitive methodology of electromyography (EMG) with observational behavioural techniques, to assess infants' capacity for imitation across four home visits (at 2 weeks, 3 months, 5 months, and 7 months) during the first 7 months of life. During each home visit, data is collected on infants' EMG and behavioural responses to facial (tongue protrusion and frowning) and manual (sequential finger movement) gestures modelled live and through video presentation. Both behavioural and EMG data will be scored using the "cross-target" comparison method, contrasting infant responses to matching versus non-matching models, to identify imitative responses. Data collection is currently ongoing with a target of n = 60 infants expected by June 2024. The longitudinal data from this study will be analysed with a series of Generalised Linear Mixed Models (GLMMs). Infants' responses will be analysed as a function of both fixed effects (time, model, mode of presentation) and random effects (participant). Both competing hypotheses predict a significant interaction between time and model: the innate proposal predicts a strong model effect at time 1, with imitative responses disappearing thereafter and reappearing at later time points. The associative sequence learning model predicts a linear increase in the size of the model effect, with imitative responses increasing as a function of time. If there is an innate mirroring system, there should be EMG evidence of imitation in the first few months, even in the absence of convincing behavioural evidence. If it fades and reappears, that should be also evident in the longitudinal data.

Preregistration

P3-A-451 - Early childhood development as the foundation of sustainable development: screening assessment in a low- to medium-income country

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Details

Early childhood development is the foundation of sustainable development and the time of greatest risk and opportunity (Daelmans et al., 2017; Fernald et al., 2009). Unfortunately, children younger than 5 years living in low- to medium-income countries experience undesirable loss of potential development (Mc Gregor et al., 2007). Child development assessments are essential for planning strategies to promote development and prevent problems (Fernald et al., 2009; Lipkin et al., 2020). Additionally, it is necessary

to examine the effects of risk and protective factors to understand the child developmental outcomes. The present study aimed to assess risks and resources in children's development and socio-emotional behavior at early ages in a low- to medium-income country. The sample comprised 355 mothers and their 395 children aged 1 to 36 months (54% boys/46% girls). Recruitment and data collection were conducted online due to the social isolation in pandemic period. Children's development and socioemotional behaviors were assessed by Survey of Well-being of Young Children (Perrin et al., 2016; Moreira et al., 2019). Maternal depression symptoms were evaluated by the Patient Health Questionnaire (Spitzer et al, 1999; Osório eta., 2019), maternal history of childhood adversities by the Adverse Childhood Experience (Felitti et al., 1998; Maia & Silva, 2007), and parental sense of competence by the Parental Sense of Competence Scale (Gibaud-Wallston & Wanderman, 1978; Linhares et al., 2018). Descriptive statistics and regression analysis were performed, with logistic regression used for developmental outcomes and multiple linear regression for behavior outcomes. Predictor factors included child variables (preterm-birth, sex) and maternal variables (depression, history of childhood adversities, sense of parental competence). The significance level was set at 5%. Firstly, in the descriptive analysis, the results showed that 68% of children presented an expected developmental level for their age, while 32% had suspected developmental delay. Also, 58% exhibited risks for socioemotional behavior alterations. Secondly, concerning maternal factors, 46% of mothers presented depressive symptoms, and 78% reported a history of childhood adversities; however, 54% revealed a good parental sense of competence. Thirdly, in the statistically significant results of the regression analysis, the preterm-born children had a higher risk of developmental delay. Conversely, as protective factors, children with highly educated mothers and families with a monthly income above U$1,031.00 had a lower risk of developmental delay. Fourthly, regarding child behavior at 1 to 17 months of age, maternal depressive symptoms, lower parental sense of competence, and a monthly family income lower than U$1,031.00 predicted significantly the inflexible behavior. Also, maternal depressive symptoms predicted significantly the children's irritable behavior, and maternal depressive symptoms, lower maternal education, and parental sense of competence predicted children's difficulty with routine. Finally, the maternal history of childhood adversities increased the risk of children's socio-emotional behavior alterations from 18 to 36 months of age. In conclusion, the assessment model, that combines the evaluation of children's development and socio-emotional behaviors and the biological and psychosocial factors, was appropriate for detecting risks and resources in early childhood. These findings support the rationale to plan preventive intervention strategies to protect child development.

P3-A-452 - Exploring the role of maternal interoceptive accuracy and attention on infant respiratory and cardiac interoception

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Details

The perception of own bodily rhythms, an ability termed interoception, has been proposed to be crucial for development in early infancy: Infants, born with limited ability for the regulation of interoceptive signals, rely on the primary caregiver for regulation and arising interactions are supposed to shape the development of minimal self and early social cognitive abilities (Fotopoulou & Tsakiris, 2017). A recent line of research has investigated interoceptive perception in infants and found that 5-6-month-old

infants already perceive their own heartbeat. However, this line of research has focused only on a narrow age range and heartbeat perception. Further, current work has not investigated the role of maternal interoception for infant interoception. Recent advances in theoretical frameworks on adult interoception highlight the need to differentiate between different facets of interoception, such as accuracy (exact perception of interoceptive signals) and attention (relevancy of interoceptive signals in everyday life), which have been found to often have opposing effects on related constructs.
Tackling these gaps in the literature, here we present results investigating cardiac and respiratory interoceptive sensitivity in 3- (total N = 80), 9- (total N = 90), and 18-month-old (total N = 54) infants. Further, we assessed maternal interoception focusing on the role of interoceptive accuracy and attention. To measure infant cardiac interoceptive sensitivity we replicated a preferential looking paradigm in which infants were presented with stimuli pulsating either synchronously or asynchronously with their own heartbeat (Maister et al. 2017). To measure infant respiratory interoceptive sensitivity we created a novel task that follows the same logic in which infants were presented with stimuli pulsating synchronously or asynchrony with their own respiration. To measure maternal interoception we used the interoceptive accuracy and attention scales.
Regarding infant cardiac interoceptive sensitivity we find that absolute proportional scores, which indicate the strength of discrimination between synchronous and asynchronous stimuli, stay rather constant across all age groups (ps > .05). Regarding respiratory perception we find that absolute proportional scores only reach similar levels as cardiac perception at 18-months, while being lower at 3- ($p = .014$), and 9-months ($p = .004$). Further, we do not find that both domains are strongly related to each other ($p > .05$). Regarding maternal interoception we find exploratory evidence that maternal interoceptive accuracy and infant cardiac perception at 3-months are positively related ($p = .036$), and that at 9-months infant respiratory perception is positively related to maternal interoceptive accuracy ($p = .031$) and negatively to attention ($p = .018$).
In sum, we present evidence that infant cardiac interoceptive sensitivity stays rather constant in the first two years of life, while respiratory perception increases towards 18-months. We do not find strong evidence for a relationship between both domains. Further, the relationship between maternal and infant interoception might differ between age groups, interoceptive modality, and dimension investigated. Given the relevance of interoception for perception of emotion or autism spectrum, our results might inform the investigation of the emergence of these concepts early in life.

P3-A-453 - Development of neural encoding and spontaneous motor synchronization to music over the first year of life.

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Details

Human adults spontaneously synchronize to music. Influential theories suggest that this capacity is a core component of human musicality and is universally shared across distinct cultures. However, the developmental trajectory of this capacity, and its underlying neural mechanisms, are poorly understood.

We recorded neural activity (EEG) and spontaneous movements from 79 infants (aged 3, 6, and 12 m.) listening to music. Results revealed that infants of all ages showed enhanced neural encoding of music as opposed to shuffled control stimuli. Neural (event-related) responses matured over the different ages, as revealed by shorter latencies and sharper peaks at 6 and 12 months. Next to the neural activity, we looked at the spontaneous movements of infants using Deeplabcut. We were able to extract 10 principal movements that infants exhibited across all ages, explaining 80% of the kinematic variance. Preliminary results suggest that 12-month-old infants moved more to music than the control stimuli. We will conduct further analyses on the rhythmic properties of infants spontaneous movements to music.

Taken together, the results indicate independent developmental trajectories of musical encoding and spontaneous movements to music. While music is readily encoded in the 3-month-old infant brain, the capacity for spontaneous body movements to music emerges at 12 months of age and likely develops further to become as precise as in adults. These findings can inform theories on the origins of musicality and its underlying neural mechanisms.

P3-B-454 - Early development of functional brain organization using high-density EEG

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Details

An essential aspect of understanding how cognition is linked to the brain lies in examining how information processing is integrated across different brain regions. A fundamental approach to assess functional integration is modeling the interdependence of activity from various sources, known as functional connectivity. Existing evidence suggests that functional networks in the brain undergo significant reconfiguration during the first three years of life. Functional MRI (fMRI) studies have indicated a shift towards more segregated yet globally efficient networks. However, while fMRI provides high spatial resolution, it doesn't capture rapid changes in neural activity. Therefore, other neuroimaging techniques, such as EEG, can complement fMRI data. As of now, only a few cross-sectional studies have delved into electrophysiological network development, yielding mixed results.

The current paper aims to examine age-related changes in patterns of brain functional connectivity in a longitudinal sample of participants, followed through a series of four sessions from 6 to 36 months of age. We assessed network connectivity at baseline using high-density electroencephalographic (hd-EEG; 129 channels) registration and delineated network development with three different connectivity parameters in both binary and weighted networks across different frequencies of brain activity: alpha, theta, and beta bands. The strength of connectivity was computed using both imaginary coherence (Nolte et al., 2004) and phase lag indices (Stam et al., 2007) across any pair of channels with clean EEG signals. Subsequently, we explored developmental trajectories for various indices of functional network organization, including local and global connectivity strength, network efficiency, modularity of the network, participation coefficient of different nodes, and propensity toward a small-world network topology.

Weighted coherence-based connectivity networks exhibited the most significant and consistent changes. Connectivity networks demonstrated a consistent linear increase in strength, global and local efficiency across different frequency bands with age. Additionally, we observed a decrease in the participation coefficient, particularly pronounced at alpha and beta frequencies. Despite this, our findings revealed that the small-world topology and modularity of the networks were present from the first session (6 months of age). Furthermore, the number of modules and the small-world propensity of the networks remained stable across ages in different frequency bands. The topology of connections, as shown in Figure 2, reveals two clusters: occipital-parietal and frontal areas with strong local connections and weaker distal connectivity. Importantly, this topology remains relatively constant across age.

In summary, our results indicate a significant age-related increase in the brain's capacity to integrate information in different frequencies of electrophysiological activity. The clustering properties of the network also increased with age, regardless of the frequency band, while maintaining a small-world topology throughout the studied age range. The functional integration of information in the brain is crucial for cognitive development. Understanding the early development of this brain feature can provide valuable insights into overall brain maturation and may offer early markers for various neurodevelopmental risks.

P3-B-456 - The impact of a community-based music program on the quality of parent-child language interactions: A one-year follow-up

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Details

Before infants say their first words, they engage with their caregivers in conversational turns, defined as back-and-forth exchanges using vocalizations and non-verbal cues that mimic the timing of verbal conversations (Hilbrink et al., 2015). During infancy, conversational turns are a distinct social aspect of the language environment that relies on the caregiver attending and responding to preverbal communication (Donnelly & Kidd, 2021). Beiting et al (2022) found that better child language outcomes at age 13 to 27 months were associated with children experiencing a higher number of multi-turn conversational episodes. Music is a highly social context during which parents engage with their young children, and it is a natural part of the daily routine for many families (Mendoza & Fausey 2021). Music enrichment programs, readily available in many communities, offer parents the opportunity to participate in weekly classes over multiple years beginning in infancy; these programs may be a valuable strategy for improving early language outcomes. Music enrichment programs not only provide opportunities for parent-infant dyads to engage in music activities during class, but they also provide parents with additional song repertoire that can boost music engagement at home.

In this secondary analysis of conversational turns, 89 parent-child dyads who previously completed one-year of either weekly Music Together (music) or play date (control) classes (intensive intervention phase) were assessed after one-year of monthly classes (maintenance phase). Conversational turns were

coded from parent-child free play episodes conducted in a laboratory environment post maintenance phase (month-24).

When examining changes in conversational turns from baseline to month 24, we observed a significant differential group change for the average number of conversational turns per episode, with the music group demonstrating a significantly greater increase compared to the control group (music change = 11.75; control change = 8.13; music – control = 3.62, 95% CI = 0.02, 7.23, p = 0.049, Cohen's D = 0.43). We also observed a significant differential group change between baseline and month 24 for the duration of conversational episodes, with the music group having a significantly higher increase compared with the control group (music change = 68.87; control change = 40.45; music – control = 28.42, 95% CI = 4.48, 52.37, p = 0.020, Cohen's D = 0.51).

These findings suggest that participating in music enrichment programs during infancy may benefit parent-child language interactions into toddlerhood. Although this is one of the first direct examinations of the benefits of music enrichment for conversational turns, music enrichment programs have been more broadly associated with improved quality of parent-child interactions including increased parent sensitivity (Nicholson et al., 2010; Vlismas et al., 2013) and decreased parent negative affect (Smith et al., 2023). This suggests that music engagement may boost language interactions through enhanced parent-child interaction (Landry et al., 2006; Madigan et al., 2015).

P3-B-457 - Moving towards naturalistic infant fNIRS - A pilot study

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Details

Object exploration is a central tenet of infant play (Herzberg, Fletcher, Schatz, et al., 2022; Karasik, Tamis-LeMonda, Adolph, et al., 2011)—a universal context of learning in infancy (Needham, 2016). This is a testament to its relevance in research and also indicates opportunity to discover brain architecture related to common behaviours of infant play across cultures. In an effort to breathe new life into infant neuroimaging research, our study utilises a naturalistic fNIRS approach–reducing the gap between laboratory tasks and daily experiences (Open Science Framework registration: https://osf.io/zc8bj, approved 1 May, 2023). While most of infant fNIRS research measured cortical correlates of cognitive processes in structured, controlled experiments, it remains unknown whether these findings translate to real-life, naturalistic scenarios. Our study employs a free play paradigm, where caregivers and infants engage in play as they typically would at home. Utilising this paradigm in a naturalistic fNIRS study will allow us to record neural responses to many daily experiences and behaviours and therefore will give us a window into the complexities of infant first-person experiences. In a pilot fNIRS study, nineteen 5- to 7-month-olds (13 female, Mage = 5.9 months), engaged in face-to-face play with one caregiver, while we recorded their brain activity using a 44-channel NIRSport2 fNIRS system. The recording continued for as long as the infant was willing to play and wear the cap (0-24 min, M = 12.16min). The mother-infant dyad played with their infant's favourite and/or novel toys. We manually coded the synchronised video-recordings marking each of the observed behaviours; caregiver vocalising (caregiver IDS, ADS/non-IDS,

caregiver singing), infant vocalising, infant crying, infant reaching for a toy, infant looking at a toy, infant touching a toy, infant mouthing,as well as the type of toy: familiar vs. novel. The ongoing data analyses will reveal the temporal dynamics of the infant's experiences during the recording session and elucidate the neural correlates of observed behaviours. The fNIRS analyses will follow two directions. Firstly, we will analyse the data as an event-related design, treating each manually coded behaviour as a new event. Secondly, we will employ a recently developed tool that allows back-logging fNIRS data to indicate events of interest. We will analyse the data as an event-related design, treating each manually coded behaviour as a new event. The project seeks to clarify how the infant brain responds to and processes information in a real-life-like setting; the specific phenomenon under study is one of many that the collected dataset will allow studying; the results of this project are expected to advance theory in neurocognitive development, particularly in regard to how some infant behaviours may reliably coincide, or even predict one another.

P3-B-458 - Test-rest reliability in remote application administration with infants

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Details

Background: Assessing infant cognitive abilities has historically been limited by the need for reliance on parent-report measures or in-person assessments that require proximity and ability to travel to the laboratory. Small sample size in infant studies has led to variable outcomes and issues with reproducibility (Debolt, Rhemtulla, & Oaks, 2020; Oaks, 2017). The development of remote methods for administering looking time tasks with infants from their home has improved our capacity to recruit and test large samples of infants. Recent evidence suggests that test-retest reliability is limited, for example, in some traditional studies of infant looking behaviors (Schreiner et al., 2023). Establishing reliability for remote assessments is necessary to support both group level research and individual assessment.

Objectives: This study assesses test-retest reliability for established measures of infant cognitive and language development that were administered as part of the Remote Infant Studies of Early Learning (RISE) Battery.

Methods: RISE is an online, scalable battery of tasks that was developed to provide a comprehensive and accessible means for studying cognitive development in infants at high likelihood for ASD. The battery includes seven different tasks; of which one is a preferential looking task in which infants view dynamic abstract geometric figures next to videos of children dancing (“Geo-Social Attention Task”) to

assess infants' preference for social stimuli (e.g., Pierce et al., 2011). Participants watch the battery from their homes at either 6- or 12- months of age, and re-watch the battery up to 1 month from the date of their first administration. During the administration, their laptop camera records a video of the participants, allowing us to complete eye tracking remotely. Eye tracking was coded using iCatcher (Yotam et al., 2023)

Results: Data have been collected for over 77 neurotypical participants, and video data for all seven measures within the battery are currently being coded. Based on data from a preliminary sample of 10 participants (6 months n = 6, 12 months n = 4, M/F=2/8), test-retest reliability was explored for the Geo-Social Attention Task. We calculated the proportion of time spent looking at the child dancing on the screen relative to total tracked time (i.e., time spent looking at the child dancing/ time spent looking at child + geometric figures). Based on this preliminary sample, we found adequate test-retest reliability with infant performance consistent across test sessions, (r(8)=.73, p = .016).

Conclusions: Remote measures that can assess infant looking time behaviors hold great potential for increased sample size in historically under-powered studies of infant cognitive development. Here we provide preliminary evidence for test-retest reliability in the RISE Battery. Data collection in our typically developing sample is nearly complete and data for all tasks will be coded by the conference date.

P3-B-459 - Exploring engagement in children's visual attention: A multi-modal analysis

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Details

The direction and regulation of attention is of vital importance to the life of an infant and is a faculty that develops throughout infancy and childhood (Ruff and Rothbart 1996). It has been established in the literature that different modes and levels of attention exist and occur across different tasks (eg Choi and Anderson 1991 and Ruff et al. 1998). A distinction has been drawn between so called 'casual' and 'focused' attention (Thomas 2012). Since the self-reporting of attentional state is not possible for infants, how can casual and focused attention be distinguished?

Deceleration in heart rate at the onset of attention has been found to be a reliable marker of focused attention (Lansink and Richards 1997). It has been proposed that sustained heart rate decreases that coincide with behavioural focus might suggest a higher level of information processing (Lansink and Richards 1997). Thus, it is possible that focused and casual attention can be distinguished via the magnitude of heart rate changes during looking.

Theta power found in the EEG has been identified as another marker of attention (Orekhova et al. 1999). In infants, increased theta power is associated with social attention (Throm et al. 2023). In the absence of social stimuli, increased theta power has been found localised over specific electrodes during sustained attention (Xie et al. 2017). In both infants and young children, theta power has been linked to states with a strong attentional load (Orekhova 2006). Conversely, attenuation in alpha power has been

found to relate inversely to focused attention (Xie et al. 2018). Theta and alpha power, therefore, emerges as another potential means for discriminating between focused and casual attention.

For younger infants, spontaneous motor movement plays an important role in the regulation of attention. Spontaneous motor movement has been found to be inversely related to attention (Bacher and Robertson 2001). Infants display less trunk movement for the duration of focused attention versus casual attention (Berger et al. 2017). However, it has also been found that infants display more spontaneous body movement immediately before the offset of a look (Robertson et al. 2007). Although a link between movement and attention remains underexplored in older infants, motor movement emerges as a possible marker of focused versus casual attention.

This project seeks to investigate the dynamics of 5-month-old infants' (n=77, mean age 6.3 months, sd 2.3 months) visual attention by analysing a dataset capturing the location and duration of their looks towards a set of objects during solo play. We aim to identify prolonged visual engagements (that is, looks within the 90th percentile of duration) and explore the above using heart rate measured via ECG, alpha and theta power as measured by EEG, and general motor movement measured by a pose detection machine learning algorithm.. These measures will be used to find clusters representing focused versus casual attention using k-means clustering. Since early-life differences in looking time may predict later life ADHD symptoms (Miller et al. 2016), distinguishing attention subtypes may provide insight into symptom development.

https://osf.io/279j8

P3-B-460 - NIH Baby Toolbox executive functioning and cognition domain

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Details

Motivation: The NIH Infant and Toddler Toolbox (Baby Toolbox) introduces novel standardized assessments of infants aged 1 through 42 months, administered entirely on an iPad tablet using automatic coding and scoring. This abstract focuses on the "Executive Functioning and Cognition" (EF-Cog) domain.

Tasks and development: Measures to assess attention, executive functioning, and memory were selected by a team of domain experts, as well as from an expert survey (n = 567) and a scoping review of the literature. Tasks were selected and adapted for iPad administration for children, including the visual delayed response (VDR) task, visual familiarization task, learning task, and delayed memory tasks. These tasks were adapted for developmental levels within the iPad and were tested for feasibility, using automated eye-tracking gaze detection for the youngest children and touch at older ages. Measures were normed and validated in a sample of 2550 infants that were representative of the racial and ethnic diversity of the US, across 12 sites around the country, in both English and Spanish (though only touch-based English results are reported here).

Results: Here, we focus our analyses on a subset of infants that completed the touch version of the EFCog tasks in English (Learning n=359, Delayed Memory n=252, VDR n=378). Preliminary item response theory scoring models were proposed for these measures, and the measure-level models had moderate reliability for a broad range of the latent trait distribution (.67-.79). Scores from these tasks were also correlated with age in months (rs=.31-.47), see Table 1.

Future directions: Ongoing analyses include generating composite model scores with the goal of confirming these scoring models with the full dataset as well as analyzing results from the Spanish-speaking sample. Test-retest reliability of these scores in a subset of participants will be assessed. A subset of infants (n=120) also completed other gold-standard measurements, such as the Bayley Scales for Infant Development and Ages and Stages Questionnaire (ASQ), in addition to Baby Toolbox measures. Convergent validity between EF-Cog scores and these external measures will be assessed. The final sample (targeted n=2550) will be re-weighted using a raking and weighting procedure to match the 2022 American Community Survey values. Then, the obtained scores will be age-adjusted for norming using a continuous, regression-based norming approach.

P3-B-461 - Eye-tracking measures of endogenous attention, arousal, and task engagement in infancy

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Details

The allocation of cognitive resources for the sake of information processing is a defining feature of endogenous attention. Yet, conventional measures of infant endogenous attention primarily rely on gross, occasionally stimulus unspecific, looking behavior measures such as look durations. Eye-tracking can offer a flexible tool for obtaining reproducible, sensitive, and concurrent measurement of attention, task engagement, and peripheral arousal system activation – which plays an important role in cognitive effort. In a cross-sectional sample of 3- to 12-month- old infants (*N* = 145), we use two gaze-contingent eye-tracking tasks (see Figure 1) for measuring the covariation between peripheral arousal indices (pupil size and head movement velocity) and various performance characteristics of two early-developing forms of endogenous attention: shifting attention and sustained attention. We also included several measures from a face-to-face social interaction with the caregiver, as well as a number caregiver-reported measures of attention development.

Pre-liminary analyses show several of the eye-movement measures that are i) reliable, ii) correlate with age, and iii) show cross-task stability between some of the measures. By way of example in Figure 2 we include the correlations plots of two measures of the sustained attention task. Both show significant developmental trends. Other interesting measures with significant developmental trends are i) a measure of head movement during tasks, as proxy of arousal/engagement, and ii) speed of attending to attention grabbers during the eye-tracking tasks.

P3-B-462 - Examining interactions between educators and across toddlers: Evaluating the validity of the responsive interactions for Learning - Educator-Child Dyad version

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Details

Differences in the experiences of individual children within early childhood education and care (ECEC) classrooms have been largely overlooked. This may be due, in part, to a lack of validated, efficient measures of dyadic interactions between educators and individual children. There is, however, some evidence that children within the same classrooms have different experiences, in terms of the quality of care they receive. This study evaluates the psychometric properties of an adaptation of the Responsive Interactions for Learning – Educator version (RIFL-Ed, design to assess educator level quality of interaction) to capture the interactions between educator-child dyads (ECD). We test the internal structure and convergent validity for this cost-effective, efficient educator-child dyad (RIFL-ECD) measure. Ninety-five early childhood educators, from 41 toddler classrooms (i.e., children between 18 and 30 months of age) across 30 centers were included. Instrument development involved the adaptation of language across items of the RIFL-Ed, using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) on separate subsamples to investigate the structural validity of the RIFL-ECD. Convergent validity was investigated by comparing RIFL-ECD scores to other measures of quality. Results of the EFA (Table 1) and the CFA (Figure 1) supported a unidimensional factor structure for RIFL-ECD, demonstrating adequate structural validity. Convergent validity investigation demonstrated correlations between RIFL-ECD and RIFL-Ed ($r = .78$, $p < .001$), however a large portion of the variance (40%) was not held in common across the two measures. Using the relevant factors from the Classroom Assessment Scoring System, we found a moderate, statistically significant, positive relationship between RIFL-ECD and the Engaged Support for Learning subscale score ($r = .32$, $p = .003$), but not Emotional Behavioral and Support subscale score ($r = .11$, $p = .267$). The findings of this study suggest the RIFL-ECD is a promising and efficient tool for assessing educator-child interactions at the individual child level, showing validity in structural and convergent aspects. The findings suggest reconsidering traditional measures collected at the classroom level in favor of the RIFL-ECD, emphasizing its practicality in capturing nuanced interaction quality. The study also underscores the need to explore variations at the child level and highlights the RIFL-ECD's cost-effective support for professional development in Early Childhood Education and Care, particularly in enhancing educator responsiveness.

P3-B-463 - Dynamic changes in periodic and aperiodic neural activity during infant sustained attention

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Details

Infant neurocognitive development can be assessed by measuring electroencephalography (EEG) during cognitive tasks. An EEG power spectral density (PSD) curve consists of two physiologically distinct

components: periodic (oscillatory) and aperiodic (PSD slope and offset) activity. Recent advancements in EEG methodology suggest using spectral parameterization to decompose the aperiodic from the periodic signal to better elucidate the precise neurophysiological mechanisms. In the aperiodic domain, PSD slope is thought to reflect cortical excitatory/inhibitory balance while the offset reflects a uniform shift in broadband power. In the periodic domain, lower frequency oscillatory power has been linked with subcortical-cortical coherence and arousal modulation while higher frequency oscillatory power is correlated with synchronized activity of localized cortical neural circuits. Importantly, spectral parameterization adopts a data-driven approach for identifying peak frequencies to derive oscillatory power estimates, deviating from the conventional methods that rely on pre-defined arbitrary frequency limits.

In the current study, we sought to evaluate dynamic changes in both aperiodic and periodic EEG activity during infant sustained attention. Seventy-seven infants were recruited at 3-months of age and provided usable attention and EEG data. To measure infant attention, we administered an engaging video stimulus and leveraged eye-gaze fixations and heart rate deceleration to characterize periods of sustained attention and inattention throughout the task. We used spectral parameterization to characterize neural activity during periods of sustained attention. Specifically, we evaluated aperiodic activity (PSD slope and offset) and periodic activity (peak frequency and aperiodic-adjusted power) during periods of infant sustained attention.

Within the aperiodic domain, there was a significant difference in PSD slope during sustained attention. Specifically, during sustained attention, PSD slope was steeper than during periods of inattention, (t=2.10, p=.04), possibly indicative of greater inhibitory relative to excitatory cortical response during phases of attention. No significant differences were observed in aperiodic offset during sustained attention. Within the periodic domain, aperiodic-adjusted theta power (mean peak frequency=5.16) and beta power (mean peak frequency= 25.42) were significantly higher during sustained attention compared to inattention (t 2.80, p 0.006). There was no change in alpha power (mean peak frequency=8.77) during sustained attention.

In summary, our findings suggest that dynamic changes in aperiodic PSD slope and periodic theta and beta neural oscillations may be key drivers of the underlying mechanisms supporting sustained attention in infancy. The results from this study offer a more precise and reliable estimate of neural mechanisms underlying attention, potentially serving as a neural marker for the early identification of neurodevelopmental disorders.

P3-B-464 - Sleep EEG slow waves and fNIRS functional connectivity in napping infants

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Details

Introduction: A key role for sleep is to facilitate memory formation. The sleeping brain achieves this via so-called slow waves (high amplitude oscillations <4.5Hz) that travel across the brain during NREM sleep

that are measured using electroencephalography (EEG). Slow waves appear to also foster functional connectivity (FC) in adults (Aedo-Jury, 2020). In infants this link has yet to be investigated. FC predicts later cognitive development in infants (Cao & Huang, 2017) and infants with more and/or higher amplitude sleep slow waves are better at learning new information (Seehagen, 2019). Here we investigate how EEG sleep slow waves co-modulate with fNIRS-measured functional connectivity as measured by wearable simultaneous NIRS-EEG.

Methods: N=34 5-to-9-months-old infants participated in the sleep study at Birkbeck Babylab, University of London, London, UK. A wearable NIRS-EEG headgear (20-channel EEG ENOBIO system (Neuroelectrics, ES)/47-channel NIRS Baby Brite system (Artinis, NL)) was used. Data quality checks/pre-processing/analyses were performed using Matlab 2022b(QT-NIRS, custom scripts, Fieldtrip, Homer2). fNIRS data was segmented into 120 second epochs and channel-by-channel correlational analyses were performed to obtain epoch-by-epoch connectivity matrices. Average power in slow wave (0.5-4Hz)/sleep spindle (11-16Hz) bands was extracted. EEG characteristics for every epoch were then linked to fNIRS FC. See Figure 1 for examples.

Results: Preliminary results of individual participants show differences in connectivity depending on nap length and length of slow wave periods. Further analyses will include group-wise analyses of common connectivity patterns and their association with slow waves as well as alternative FC analyses such as dynamic functional connectivity.

Conclusion: Results show preliminary evidence that studying slow waves in association with FC during a nap could provide information on how sleep impacts development. Slow waves could indeed modulate functional connectivity showing a cascading impact on development. In the long run this study has implications for sleep interventions as e.g., slow waves can be modulated by auditory stimulation.

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P3-B-465 - The role of mothers' rejection of children understanding toddlers' temperament and smart device use

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Details

We have been exposed to smart devices in everyday life. As the use of digital media becomes increasing rapidly, the undeniable reality is that even younger children are gaining more access to smart devices. The prevalence of smart devices in young children's lives has changed their ways of interacting with others, and developing essential skills.

Among a variety of factors which have influence on human beings during one's entire life, mothers, in particular, have an effect on various parts of development of infants and toddlers. Therefore, the purpose of this study is to investigate the mediating role of mothers' rejection of young children in the relation

between 2-year-olds' difficult temperament and their smart device use. Few studies have examined the role of mothers' rejection of children understanding young children's temperament and smart device use; therefore, considering the mechanisms of mothers' rejection of young children on the association between infants and toddlers' difficult temperament and their engagement in smart device use is necessary.

Data were collected from 215 Korean mothers of children aged between 24 to 36 months from childcare centers located in Korea. Mothers' rejection of children (Kim & Rohner, 2002), young children's difficult temperament (Abidin, 1995), and their engagement in smart device use (Lee, Jung, & Kim, 2015) were measured by mothers. Children's sex and month were considered as covariates. Data were analyzed by descriptive statistics, Cronbach alpha, correlation, and the hypothesized model was verified using structural equation modeling analysis.

The results were as follows. First, two-year-olds' difficult temperament was positively related to mothers' rejection of children, which was also positively associated with young children's engagement in smart device use. Second, the research model was selected as a final model which implied that 2-year-olds' difficult temperament had an indirect effect on their engagement in smart device use data (χ^2= 67.776 (*df* = 33, *p* <.001), CFI = .958, TLI = .942, SRMR = .054, RMSEA = .060, 90% confidence interval (CI) for RMSEA [.036, .084]). Lastly, mothers' rejection of their young children had a significant mediating effect in the relation between young children's difficult temperament and their engagement in smart device use (β = .154, *p* < .01, 95% C. I. [.042 ~ .266]). The research model as illustrated in Figure 1.

Based on the results of this study, it can be implied that is necessary to promote parents' positive parenting attitudes within family contexts in order to make developmentally appropriate media environments for their young children, and the related implications of these findings and future suggestions will also be discussed.

P3-B-466 - A new pipeline to process infant ECG acquired in naturalistic environments

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Details

Variations in heart rate (HR) are linked to cognitive functions (e.g., attention) that are important for infant development. HR calculated from infant electrocardiograms (ECG) can help us better understand the development of these functions. Particularly of interest are longform (≥5 minutes) recordings acquired while infants behave freely in their natural environments. However, such naturalistic recordings are often very noisy, and can take a long time to process. Although there are existing open-source ECG approaches, these have been developed specifically for adult ECG. Adult ECG and infant ECG are fundamentally different, as adult HR is much slower than infant HR.

We propose a new ECG pipeline (Figure 1) which builds on the existing Neurokit2 approach (Makowski, 2021). Our pipeline contains a number of innovations to address the challenges with processing longform

infant ECG: a 15Hz high pass filter in preprocessing; local peak correction to increase labelling accuracy; a HR cleaning algorithm; and a HR signal quality index (SQI).

Our pipeline has been validated on longform infant ECG data acquired under a naturalistic environment (N=97; 52.3 total hours; sampling rate 500 Hz). We compare its performance against existing open source methods, as measured by specificity, sensitivity and positive predictive value. Specificity measures how well an approach does not place a label when considering all places where it shouldn't. Sensitivity measures how well a method places a peak label, when considering all places that should be labelled. PPV measures the proportion of peaks detected which are correct.

Our proposed pipeline's median specificity, sensitivity, and PPV (0.999989, 0.9958, 0.9975) outperformed the median results of all other methods, the closest being Neurokit2 (0.999975, 0.9863, 0.9938). If we interpret these median results on our average signal length (30.5 minutes, 4180 peaks), it would mean: 13 fewer peaks labelled incorrectly (10 vs 23), 29 fewer peaks missed (18 vs 57) and only 0.25% of peaks that were identified were labelled incorrectly (vs 0.72% for Neurokit2). It can also be clearly seen that our approach has the best-performing worst-case of any method (e.g. the worst performing result is the least-bad with our method).

The HR cleaning and SQI also allow for more reliable analyses of much noisier data to maximise the amount of good HR signals recovered. That is, our pipeline allows for much less rejection of data acquired in a naturalistic environment. Additionally, it is very computationally efficient, able to analyse multiple hours of data in seconds with typical computer hardware. Thus the work will provide an open source pipeline for researchers hoping to use infant ECG analysis with confidence in their future research, especially for naturalistic recordings.

P3-B-467 - Utility of the Childhood Autism Rating Scale to detect autism spectrum disorder in young children under 36 months of age

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Details

Background: Autism spectrum disorder (ASD) is thought as an innate and lifelong neurodevelopmental disorder and characterized by impaired social interaction and communication, as well as restricted and repetitive behavior and interest. Recent studies have shown an increasing prevalence of ASD, indicating a growing population in need of early intervention. Previous studies reported that early intervention improved prognosis and outcomes for young children with ASD before 36 months of age. The benefits of early intervention highlighted the importance of earlier identification of young children with ASD.

Objectives: There are limited studies on ASD screening tools for at-risk young children before 36 months of age in Taiwan. Therefore, this study aims to examine the utility of the Childhood Autism Rating Scale (CARS) for detecting ASD in young children under 36 months of age.

Methods: Two studies were conducted to evaluate the validity of CARS for detecting developmental disabilities in young children before 36 months of age. The CARS consists of 15 items that describe various behaviors associated with ASD. Each item is rated on a 7-point scale, with scores ranging from 1 to 4. Study 1 used receiver operating characteristics (ROC) to select a cutoff score for the CARS. It involved 2 groups of 30 toddlers each, 1 group with toddlers having ASD and the other group with chronological and mental age-matched toddlers with developmental delays (DD). Study 2 involved 206 toddlers with developmental disabilities before 36 months of age, including 115 with ASD, 34 with mild-ASD, and 57 with DD, to validate the consistency of the CARS cutoff scores with clinical diagnosis.

Results: Through analysis of young children with developmental disabilities before 36 months of age in Study 1, the findings suggested that the optimal cutoff scores to be between 28 and 29. Using the 28 and 28.5 of the CARS score as cutoffs, the sensitivity and specificity are .93 and .90, respectively. Using the 29 of the CARS score as cutoff, the sensitivity and specificity are .90 and .90, respectively. Study 2 confirmed the optimal cutoff score of 28 and 29 for the CARS and demonstrated good accuracy with clinical diagnosis in samples of young children with developmental disabilities before 36 months of age. Besides, using 28 and 28.5 of the CARS as cutoff scores, the concurrent agreement between CARS and clinical diagnosis yielded high sensitivity (.79-89) and specificity (.81).

Conclusions: The CARS can be utilized as an effective Level 2 autism-specific screening tool for distinguishing young children with ASD from those with DD before 36 months of age. Consistent with previous studies, the findings of this study supported that a lower cutoff score might be needed for accurate identification of young children with ASD using the CARS in Taiwan. The CARS is a valuable early screening tool for ASD to be promoted and adopted in clinical practice. This study provides important insights and guidance for clinicians and healthcare professionals involved in early ASD screening.

P3-B-468 - Similarities and differences in the functional architecture of mother- infant communication in rhesus macaque and British mother-infant dyads

Valentina Sclafani [1], **Leonardo De Pascalis** [2], **Laura Bozicevic** [2], **Alessia Sepe** [3], **Pier Francesco Ferrari** [4], **Lynne Murray** [5]

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Details

Similarly to humans, rhesus macaques engage in mother-infant face-to-face interactions. However, no previous studies have described the naturally occurring structure and development of mother-infant interactions in this population and used a comparative-developmental perspective to directly compare them to the ones reported in humans. Here, we investigate the development of infant communication, and maternal responsiveness in the two groups. We video-recorded mother-infant interactions in both groups in naturalistic settings and analysed them with the same micro-analytic coding scheme. Results show that infant social expressiveness and maternal responsiveness are similarly structured in humans and macaques. Both human and macaque mothers use specific mirroring responses to specific infant social behaviours (modified mirroring to communicative signals, enriched mirroring to affiliative gestures). However, important differences were identified in the development of infant social

expressiveness, and in forms of maternal responsiveness, with vocal responses and marking behaviours being predominantly human. Results indicate a common *functional architecture* of mother-infant communication in humans and monkeys, and contribute to theories concerning the evolution of specific traits of human behaviour.

P3-B-469 - Assessing social responses of infants to strangers in an online task: Insights from human coding and FaceReader analysis

Yiyi Wang [1], **Marc Colomer** [1], **Hyesung Grace Hwang** [2], **Caroline Groves** [3], **Amanda Waite** [3], **Sydney Takemoto** [4], **Courtney Filippi** [3], **Amanda Woodward** [1]

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Details

Observationally coding infants' social responses is crucial for studying early social development. Due to challenges in recruiting infants for in-person research, researchers have increasingly turned to online studies using platforms like Lookit (Scott & Schulz, 2017). This approach allows for larger, more diverse samples and provides new possibilities for data sharing and analytic innovation. However, little is yet known about how and whether online studies can capture meaningful variation in infants' social behavior. The current study aimed to assess infants' social responses to strangers in an online, non-contingent paradigm, and to test two modes of coding: human coding of holistic social behavior and AI coding of facial affect. Infants saw one adult who spoke their native language (English) and another who spoke a language that was unfamiliar to them (Spanish). Based on prior research (Kinzler et al., 2007; Liberman et al., 2017), we predicted more positive responses to the native-language speaker.

To measure infants' social responses to different speakers, we invented an online stranger approach task based on prior studies (Feinman, 1980; Fox et al., 2001). In the task, infants viewed three videos (approaching, playing peekaboo, making animal sound) of two speakers alternately. Twenty-three infants from monolingual English-speaking homes (Mean age = 18.67 months, SD = 1.17) participated in the study. We developed a social response scale assessing infants' reactions. The scale combined facial expressions with interactive behaviors like imitation, approaching, avoidance, and social referencing. The scale had 5 levels, ranging from -2 (very negative) to 2 (very positive) (see Table 1). Two human coders coded independently, showing good inter-rater reliability (ICC = 0.954 at subject level, 0.771 at trial level). We compared the coding results with FaceReader, a software tool utilizing deep artificial neural networks to automatically analyze facial expressions based on the Facial Action Coding System (FACS, Ekman et al., 2002). FaceReader generated the valence (i.e., whether the emotional state of the subject is positive or negative) and arousal (i.e., whether the subject is active or not) of facial expressions.

Human coding scores based on the social response scale were positively related to the valence assessed by FaceReader ($r = .48$, $p < .001$), even after accounting for arousal and video quality ($\beta = 5.90$, $p < .001$, 95%CI [4.70, 7.11], see Figure 1). Only human coding successfully differentiated infants' responses to the native-language speaker compared to the unfamiliar-language speaker ($\beta = 0.22$, $p = .001$, 95%CI [0.09, 0.35]). Infants exhibited more positive responses to the native-language speaker, aligning with previous

findings. These results suggest that the social response scale provided an effective way to assess infants' social responses in an online task. However, valence and arousal measured by FaceReader did not differentiate between infants' responses to the two speakers. This approach reveals the importance of integrating both facial expressions and social interactive responses when assessing infants' social responses in online tasks.

P3-B-470 - BabyFaceReader: Quality checking challenges and solutions

Caroline Groves [1], **Amanda Waite** [1], **Sydney Takemoto** [2], **Yiyi Wang** [3], **Hyesung Grace Hwang** [4], **Marc Colomer** [3], **Amanda Woodward** [3], **Courtney Filippi** [1]

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Details

Quantifying infant affect is central to the study of social-emotional development. Yet, manually scoring affect is time-intensive, and maintaining high reliability can be challenging (Chorney et al., 2015). Advances in automated solutions employing AI technology (e.g., computer vision) pose great promise. FaceReader is an emerging facial analysis software that uses a Facial Action Coding System (FACS; Ekman & Friesen, 1978) to classify emotion states (Lewinski et al., 2014; Stöckli et al., 2018; Zhang et al., 2021). To date, a few studies have utilized FaceReader in the analysis of adult affect (Onal et al., 2023; Oster et al., 2021) but no study has utilized FaceReader in the analysis of infant affect. A new extension of the FaceReader Software, BabyFaceReader, adapts the algorithm for use in infants ages 6-24 months (Oster, 2016). While the adaptations account for infants' smaller faces, one key difference between infant and adult video data is that infant data often includes the faces of both infants and parents because infants frequently sit on their parent's lap during studies. To date, it remains unclear how to ensure that BabyFaceReader is capturing infant faces rather than adult faces. The current study evaluates the propensity of BabyFaceReader to pick up infant faces and identifies a quality-checking process that ensures high-quality data.

To do so, we used data from a Lookit pilot study (N= 25; M_{age} = 20.08 months, SD_{age} = 1.74, Range 17 to 22 months; 16 males) that examined infants' reactions to strangers. Videos were fed to the BabyFaceReader algorithm. For quality control purposes, we first extracted automated video quality estimates. Next, research assistants (RAs) manually scored whether a non-infant participant's face was present in the video (yes/no), and, if so, reviewed the algorithm's visualization to evaluate whether the non-infant face was automatically analyzed. When another face was captured by the algorithm (See Figure 1), manual intervention was applied to minimize the facial window such that it only captured the infant face (See Figure 2). Following manual correction, RAs reviewed the face mesh output to determine intervention success (i.e., the algorithm only captured the infant's face).

Results demonstrated that 68% of videos had a non-infant face present. Of these, the algorithm picked up on the non-infant face 94% of the time. However, after manual intervention, the algorithm was 100% successful in disregarding the non-infant face. The contrast before and after manual intervention suggests the importance of quality control in utilizing BabyFaceReader in infant studies.

In summary, this work provides quality control guidance for BabyFaceReader users. The BabyFaceReader software shows great promise for the analysis of infant affect, yet the current project showcases the necessity of a quality check system. Future analyses will compare manual scoring of infant affect to affect scores automatically generated by BabyFaceReader to validate this analysis tool.

P3-B-471 - Word segmentation abilities in German-learning 5-to-6-month-olds: Evidence from pupillometry

Mireia Marimon [1], **Victoria Mateu** [2], **Barbara Hoehle** [3], **Megha Sundara** [2]

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Details

To learn new words, infants must first determine where words begin and end in continuous speech. Infants start extracting words from fluent speech between 6 and 7.5 months of age (in English, Jusczyk & Aslin, 1995). Like their English- and Dutch-learning peers (Jusczyk et al., 1999; Houston et al., 2000; Kuijpers et al., 1998; Kooijman et al., 2009), German-learning infants show a listening preference for trochaic over iambic words by 6 months (Höhle et al., 2009) and are able to segment words from a speech stream following the trochaic stress pattern of their native language (Marimon et al., 2022; Höhle & Weissenborn, 2003). In this study, we used pupil dilation to investigate German-learning infants' ability to segment bisyllabic nonce words from natural speech.

We tested German-learning 5- to 6-month-olds (n = 14, target N = 30) in a central fixation paradigm with eye-tracking. Infants were familiarized with passages containing two nonce words used as verbs (e.g., *rieken* /ri:kən/, *pahlen* /pa:lən/) until they had accumulated 45 s of listening time to each. Then they were tested on four isolated words: two familiar (*rieken, pahlen*) and two novel (*wühnen* /wy:nən/, *tuhpen* /tu:pen/). Preliminary results show that while the difference in looking time between novel vs. familiar test trials was not significant (p = .88), infants pupils did dilate significantly more to novel than to familiar words at test (p < .01; Figure 1). Our results provide the earliest evidence of bisyllabic word segmentation in German-learning infants (5-6 months of age) from natural speech passages using pupil dilation - which we find is a more sensitive measure to index infants' segmentation abilities compared to the traditional measures based on looking time.

P3-B-472 - The prenatal concept of number: Evidence of visual processing of stimuli before birth

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Details

Much debate has surrounded the ontogeny of human understanding of the physical world, be this a capacity present at birth or, alternatively, learned through development and experience of the world, either passively or as a conscious construction of knowledge by the infant. This debate is well illustrated

through the investigation of infants' understanding of number. Many assume that establishing the presence of a number system in very young infants provides evidence for genetic underpinnings (e.g. Wynn, 1992).

As with many visually-assessed cognitive capacities though, the study of the development of numerical processing does not extend to prenatal research, primarily due to the technical complexities of delivering visual stimuli and measuring behavioural responses by foetuses. We consequently aimed to address the question of whether processing of number sets can be detected before birth using visual stimuli and methodology more akin to postnatal studies with controls developed in the infancy literature (e.g. Clearfield et al., 2001; Starkey et al., 1990). In the first sample, 88 foetuses were tested at 34 weeks gestation. Using a custom-made light source, sets of two and three dots were presented on alternate trials (order counterbalanced across the sample) for 45 seconds (fig. 1). Stimuli were held stationary for the trial to the periphery of the foetal face and light levels continually increased and decreased to control for variance in amount of luminance between conditions. This was then repeated for a second block, for a total of three minutes. Using 4D ultrasound, foetal head movements related to the visual stimuli were measured. Foetuses were excluded where good-quality imaging could not be obtained. In the final sample, 43 fetuses turned significantly longer towards than away from the 2-dots display, Wilcoxon rank, $z = 2.309$, $p = 0.021$ (fig. 2). However, they showed no difference in preference for turning towards compared with away from three dots. Results are consistent with those reported in neonatal research indicating differential attention to number sets (Coubart et al, 2014). In a second sample of 71 foetuses, behavioural coding is currently underway to compare foetal looking in the same paradigm to 1- compared to 2- dot number sets. This work provides evidence for the utility of applying postnatal visual experimental techniques to a prenatal sample when coupled with ultrasound behavioural measures. Further, this work indicates an emerging concept of number before birth and before postnatal experience. In this poster, we explore the potential contributions of both genetics and prenatal experience on development.

P3-B-473 - Screen-based setting vs. real-life: direct comparison of infants' attention to faces at screens and during free play

Zuzanna Laudanska [1], **Szymon Maka** [1], **Itziar Lozano Sánchez** [2], **Magdalena Szmytke** [2], **Anna Malinowska-Korczak** [1], **Karolina Babis** [1], **Przemyslaw Tomalski** [1]

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Details

Many studies investigated infants' visual attention to silent and talking faces using screen-based eye-tracking (e.g., Bastianello et al., 2022; Lewkowicz & Hansen-Tift, 2012; Lozano et al., 2022; Mercure et al., 2019; Morin-Lessard et al., 2019; Tomalski et al., 2013; see also Birulés et al., 2023 for a review). The issue of attention to talking faces in infancy is important to understand since previous research suggests that infant gaze to faces could scaffold vocabulary construction (see review in Belteki et al., 2022).

However, screen-based eye-tracking does not account for the constraints of the body and environment on infant looking. Research conducted with head-mounted cameras and wearable eye-trackers suggests that infants are also highly interested in hands, objects, and surroundings (e.g., Franchak et al., 2017;

Kretch et al., 2014; Luo & Franchak, 2020; Yu & Smith, 2013). For this reason, more research is needed to better understand the cross-contextual generalizability of infant visual attention. Do infants who look more frequently at talking faces during social interactions also look longer at talking faces on screens?

Here, we will present the preliminary results of a study that measured 5-7-months-old infants' visual attention using screen-based and wearable eye-tracking. Screen-based eye-tracking (Gazepoint GP3) was used to measure infants' looking duration during free-viewing actresses reciting child-friendly stories and nursery rhymes. The total duration of the eye-tracking task was around 6 minutes. Wearable eye-tracking (Pupil Labs Neon) was used to measure infants' looking at faces during semi-naturalistic play with their caregivers. There were 4 different tasks with different sets of objects as well as short breaks when experimenters were also present in the room to switch the sets of toys. The total duration of each recording was around 27 minutes. The study is ongoing (expected $N = 60$), and so far, 10 participants have contributed data in both types of eye-tracking tasks. This pioneering cross-contextual approach will bridge infants' gaze behaviors in an experimental context and real life.

P3-B-474 - Psychometric properties of the NIH Baby Toolbox: Validity, Reliability and Norming Results

Aaron Kaat [1], **Elizabeth Dworak** [1], **Lihua Yao** [1], **Hugh Adam** [1], **Maxwell Mansolf** [1], **Y. Catherine Han** [1], **Richard Gershon** [1]

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Details

Birth to four years is a critical period of development. Tracking healthy development requires robust and sensitive measurement tools. Although various standardized, normed early developmental assessments exist, extant measures are time-intensive, costly, and require highly trained experts to administer, score, and interpret. In response to a Spring 2019 contract solicitation from the National Institutes of Health (NIH) Neuroscience Blueprint, with management by the National Institute of Child Health and Development, we assembled a large team of researchers from around the United States to produce a tablet-based set of developmental measures available for use with diverse populations: The NIH Baby Toolbox (NBT). This presentation will describe the validation and norming effort for the NBT.

Norming and validation were conducted between May and December 2023 in a nationally representative sample of 2550 English and Spanish speaking infants between the ages of 1 and 48 months. We developed sampling targets based on 5-year estimates of the 2019 American Community Survey (ACS) Public Use Microdata Sample, which allows for unique demographic combinations and nestings not generally reported by the US Census Bureau. Targets included primary language spoken to the child by race/ethnicity nested within geographic region, age, sex assigned at birth, and maternal educational attainment. We will report unweighted and weighted (for the 1-years 2022 ACS estimates) demographic breakdowns by age, race, ethnicity, and parental education.

To establish convergent validity, all caregivers of the child participants completed the Ages and Stages Questionnaire (ASQ-3), which assesses communication, gross motor, fine motor, problem solving, and personal-social skills. A subset of participants (n=120) returned within ten days of original administration to complete the Bayley Scales of Infant and Toddler Development (Bayley-4), which covers Cognition,

Language, Motor, Social-Emotional, and Adaptive Behavior. Finally, n=220 participants returned within seven days after the first testing session to be re-administered the NBT a second time, to assess test-retest reliability. The final sample will be weighted using a raking and weighting procedure to better match the census targets. Then, obtained scores will be age-adjusted for norming using a continuous, regression-based, norming approach.

The norming process is ongoing, with data collection expected to be completed by the end of December 2023. Item response theory-based scoring models are being generated for each measure and domain using a subset of the full dataset. Table 2 displays correlations with age for a portion of the 35 Baby Toolbox measures using a subset of the full norming sample. As the Baby Toolbox is required by contract to be released in 2024, scoring models for all 35 measures will be completed by summer 2024 and confirmed with the full dataset by the time of ICIS. In addition to correlations with age, we plan to present data on test-retest reliability, as well as convergent validity between Baby Toolbox scores and the two external measures, ASQ-3 and Bayley-4. Additionally, sample weight distributions and age-based reference values will be reported.

P3-B-475 - Maternal early beliefs, stimulation at home, and interaction quality shape infants' developmental outcomes in real time

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Details

Introduction: Parents' ability to employ the physical and mental resources at their disposal is critical to a child's development (Bradley, 2009; Schuurmans et al., 2022). The maternal innate state (e.g., beliefs and perceptions) affects infants' care (Ramirez et al., 2023). Key aspects such as maternal moment-to-moment responsiveness—including temporal contiguity, contingency, and multimodal and didactic content (Tamis-Lemonda & Lockman, 2020)—and the variety of stimulation provided at home enhance interaction possibilities and quality. Numerous studies have focused on maternal responsiveness to infants' communication initiatives (Karasik et al., 2014; Lucca & Wilbourn, 2018). This study aims to broaden the context of maternal responsiveness by examining how early perceptions of infants' caring principles, concrete verbal feedback, and the variety of stimulation offered impact infants' cognitive outcomes.

Hypotheses: Maternal early endorsement of an attuned caring style, variety of toys, and meaningful verbal feedback are positively associated with infants' communication and play outcomes.

Study population: The sample included 26 infants between 12 and 18 months old who were videotaped at their homes in the presence of their mothers. The infants received 22 small replicas of common household objects.

Methods: The Baby Care Questionnaire (Winstanley & Gattis, 2013) assessed maternal early care principles and practices. Infants' communication and play skills were evaluated using the MacArthur–Bates Communicative Development Inventories questionnaire (full version) (Fenson, 2007), the level of

production of communicative gestures (showing, gesturing, and pointing), and play vignettes during interaction.

Maternal interaction quality was measured by analyzing responses to infants' communicative bids. The PICCOLO (Roggman et al., 2013) was used to measure affection and teaching in maternal behavior during interaction. To determine the variety of stimulation at home, the AHEMD-IS questionnaire (Caçola et al., 2015) was completed by the mothers.

Results: A more attuned maternal caring style was found to be positively associated with maternal tendency to label objects during interaction (r = .308, p<.05) and negatively associated with not responding to infants' communicative gestures (r = .307, p<.05). Early endorsement of a more attuned caring style was found to be linked with communicative (r = .316, p<.05) and play (r = .298, p<.05) outcomes. The number of toys at home was found to be linked to play (r = .420, p<.001) and gesture production (r = .478, p<.005). Labeling objects (r = .679, p<.001), pretending with the offered object (r = .620, p<.001), and showing affection (r = .422, p<.001) were positively associated with infants' communicative outcomes. Maternal affirmation following infants' bidding acts was negatively associated with gesture (r = .312, p<.05) and play (r = .387, p<.05) production.

Conclusion: Maternal responsiveness is multifaceted, encompassing caring principles, practical steps to enrich the home environment, and the quality of verbal feedback, all of which affect infants' communication and play skills.

P3-C-476 - Perinatal Asphyxia – a risk factor for affective instability, impulsivity, and borderline-features?

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Details

INTRODUCTION:

Four million newborns a year experience oxygen deprivation during birth, which may lead to severe brain damage. Perinatal asphyxia (PA) is among the most common birth complications globally, contributing to high mortality and morbidity in the neonatal period. Perinatal asphyxia can cause structural and functional brain anomalies, acting as a vulnerability factor for later mental health issues. Previous studies link perinatal asphyxia to behavioral and emotional problems in children. Furthermore, higher rates of ADHD, schizophrenia, and bipolar disorders have been linked with perinatal asphyxia. Despite these findings, a comprehensive examination of its role in the pathogenesis of borderline personality disorder (BPD) is lacking. This study investigates whether perinatal asphyxia is associated with a BPD diagnosis, potentially predisposing the development of the disorder.

METHODS:

In this case-control study, 100 patients with a BPD diagnosis and 100 healthy control subjects matched for age, gender, and education were examined. By means of semi-structured interviews, information on perinatal stressors and birth complications were gathered from patients, their mothers, and relevant

medical records. Alongside perinatal asphyxia, other complications, such as fetal malpositions and medical interventions during birth (e.g., cesarean section, vacuum extraction, forceps delivery) were documented.

RESULTS:

Compared to the control group, individuals with BPD were significantly more often affected by perinatal asphyxia (10% vs. 1%, p=.008). However, no significant differences were observed in other birth complications. After adjusting for various control variables, individuals experiencing perinatal oxygen deprivation had a 14-fold increased risk of BPD (OR=14.03, p=.02). Moreover, perinatal asphyxia emerged as a significant predictor for BPD-specific subdomains such as impulsivity (p<.01), affective instability (p=.02), and dissociation (p<.01).

DISCUSSION:

Our results suggest that perinatal asphyxia may contribute to the development of characteristic features of BPD. Neurobiological studies support these findings by revealing brain anomalies resulting from PA. These neurobiological changes could render individuals more susceptible to deficits in behavior and emotion regulation, exacerbated by acute stressors. Future research should unravel the mechanisms and further investigate the impact of oxygen deprivation on BPD through prospective longitudinal studies.

P3-C-477 - Effects of an early support path for parents of children with visual impairment

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Details

Background

Early visual impairment can hinder the development of the initial bond between the infant and their parents (Vervloed et al., 2020; Grumi et al., 2021). Factors associated with the severity of the visual impairment, such as the child's use of atypical behaviours in response sensory inputs (Long et al., 2019), or the burden of an early diagnosis (Bujnowska et al., 2019), might increase parental stress and compromise the parents' postnatal attachment (Troster, 2001). We previously showed that parents of young children with total blindness (TB) feel more stressed than parents of partially blind children (PB) as they perceive their child as 'difficult'. We observed a trend of association between higher maternal stress and fewer head turns towards the parents during social interactions (Gui et al., 2023). In this pre-registered study (https://doi.org/10.17605/OSF.IO/45PV7) we aim to replicate these findings and evaluate whether parental perceived stress and their attachment to the child can benefit from the Robert Hollman Foundation (RHF) Early Support Path.

Participants

Infants aged between 0 and 24 months and their families will be recruited among those who are referred to the RHF centre for children with visual impairment and their families in Padua (Italy).

Power analyses in G*Power 3.1 indicated that a sample of 30 families would give us 80% power for the replication. Fifteen of these will be in the TB group (child with no light perception, or with a residual vision corresponding to a Snellen acuity > 20/6400) and 15 in the TB group (Snellen acuity > 20/6400 and < 20/400).

Methods

The RHF Early Support Path consists in a five-visits weekly intervention delivered by a multi-disciplinary team, including a psychologist, a therapist, an orthoptist and an ophthalmologist. This team will help parents to appreciate the unique characteristics of their child with low vision, and accompany them to understand the clinical diagnosis and its consequences for their child's development.

We will collect questionnaires on parental stress (Parenting Stress Index, PSI), maternal attachment (Maternal Post-natal Attachment Scale), children's temperament (Infant Behavior Questionnaire-Revised) and adaptive behaviour (Vineland Scales of Adaptive Behavior), as well as video-recordings of the parent-child interaction (PCI) before the first visit (T0) and at the end of the RHF Early Support Path (T1). The children's neurobehavioural responses (inspired by Brazelton's behavioral assessment) and developmental level (Bayley Scales) will be assessed at the first and last visit (Figure 1).

Analyses

First, we aim to replicate effect of blindness group on parental stress and its relationship between children gaze/face shifts during PCI at T0. Second, we will test whether we observe a change from T0 to T1 in parenting stress and attachment scores when correcting for the child's concurrent developmental quotient and adaptive behavior. Third, we will examine whether blindness group, the child's sensory-motor level, and the overall joint engagement in the PCI are associated with parental scores.

Implications

This study will provide preliminary evidence to evaluate whether early support to parents produce measurable changes in their availability to 'tune in' with their severely visually impaired child.

P3-C-478 - Enhanced pupillary light reflex in infants is associated with concurrent markers of social communication

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Details

The pupillary light reflex (PLR) refers to the constriction of the pupil in response to light and is an indicator of autonomic system functioning. Past research by Nyström et al. (2018) suggests that an altered PLR in infancy could be a marker of later developmental difficulties. Specifically, infants aged 9-10 months with and without an older autistic sibling completed a PLR task, and when looking across the full sample of infants, those with a stronger PLR in the first year showed increased autism-related symptoms at 36 months, most notably in the social communication domain (Nyström et al., 2018). The current study extends this approach to ask whether the PLR is associated with concurrent measures of social communication in infants as well, focusing on a group with no family history of autism.

Thirty-four infants between the ages of 6 and 18 months (M_{age} = 11.5 months, *SD* = 4.3) were included in the current sample. While seated on their caregiver's lap, infants viewed PLR stimuli adapted from Nyström (2015), consisting of fixation animations on a black screen interspersed with a 120 ms white screen to induce pupil constriction. A SensoMotoric Instruments (SMI) RED eye-tracking system collected pupil size data from both eyes at 120 Hz. Caregivers completed the Communication and Symbolic Behavior Scales Developmental Profile (CSBS-DP; Wetherby & Prizant, 2002) as a measure of social communication that yields a Total score as well as three composite scores: Speech, Symbolic, and Social. Relative constriction amplitude was calculated as $(A_0^2 - A_m^2)/A_0^2$, where A_0 is baseline pupil diameter and A_m is minimum diameter (e.g., Fan et al., 2009). PLR latency was calculated as the median latency to reach the point of maximum negative acceleration (see Nyström et al., 2015).

CSBS-DP Total score was significantly and negatively correlated with relative constriction amplitude ($r(32) = -.387$, $p = .024$; see Figure 1), suggesting that a stronger PLR was associated with reduced social communication at the same age. Associations with PLR constriction also held for the CSBS-DP Speech Composite score ($r(32) = -.351$, $p = .042$) and the Symbolic Composite score ($r(32) = -.385$= $p = .025$), and a marginal association was found for the Social Composite score ($r(32) = -.319$, $p = .066$). Scores on the CSBS-DP were unrelated to PLR latency (*p*s > .18)

The current study found that a more reactive pupillary response in 6- to 18-month-old infants was related to increased social communication difficulties at the same age. Past work looked at infants with and without an older sibling with autism as a group and found that the PLR may be informative for predicting social communication in early childhood (Nyström et al., 2018), but the present findings indicate that even without the inclusion of infants with a family history of autism, the PLR in infancy is related to variation in social communication abilities. Future work should continue to examine this relationship longitudinally to understand how these associations might shift with age in relation to social communication and other autism-related characteristics (see Soker-Elimaliah et al., 2023).

P3-C-479 - Mother-infant dyadic behavioral dynamics and infant cortisol responses to the still-face paradigm

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Details

The ability to regulate behaviors, emotions, and physiology in response to contextual demands holds implications for lifespan health and well-being (Lobo & Lunkenheimer, 2020). During infancy, the emergence of regulatory abilities occurs primarily through bidirectional coordination of emotions,

behaviors, and physiology between caregivers and infants (Feldman, 2007; Gianino & Tronick, 1988). From a theoretical perspective, both affective synchrony (e.g., proportion of shared positive interactions) and the temporal structure (e.g., the ability to flexibly readjust behaviors on a moment-to-moment basis and in response to environmental demands) undergird the development of infant regulatory abilities (Grumi et al., 2022; Hollenstein et al., 2013; Smith & Thelen, 2003). However, few studies have tested how moment-to-moment dyadic parent-infant behavioral dynamics relate to infant biobehavioral regulation, particularly during stress. To address this gap, this study tests associations of maternal-infant dyadic behavioral dynamics pre-stress, post-stress, and changes from pre- to post-stress with infant cortisol responses to the Still-Face Paradigm.

At a laboratory visit when infants were 6 months old, mother-infant dyads (*n*=79) completed the Still-Face Paradigm (2-min baseline play, a 2-min Still-Face, 2-min reunion play). Mother and infant behaviors during the Still-Face Paradigm were coded on a micro-timescale in 3 second epochs with the Infant and Caregiver Engagement Phases (kappa>0.67; Tronick et al., 2005). To assess infant cortisol reactivity, cortisol was assayed from infant saliva samples collected +0, +15, and +30 minutes after the Still-Face Paradigm. We used State Space Grids, a dynamic systems methodology, to model dyadic mother-infant behavioral dynamics (Hollenstein, 2013) and derived two measures of dyadic behavioral dynamics: (1) mutual positive engagement (shared state of mother-infant positive affect) and (2) dyadic variability (the degree of flexibility in mother-infant behaviors). We tested each dyadic behavioral measure during baseline play, reunion play, and changes from baseline to reunion as predictors of infant cortisol reactivity to the SFP, controlling for maternal age, parity, infant sex, and infant APGAR score.

Mutual positive engagement did not significantly change from baseline (M=0.41, SD=0.16) to reunion play (M=0.14, SD=0.16; t(78)=1.23, p=.22) whereas dyadic variability significantly increased from baseline (M=1.71, SD=0.86) to reunion play (M=1.82, SD=0.42; t(78)=-1.92, p=.05; Figure 1). Dyadic variability during reunion play was associated with lower infant cortisol reactivity to the SFP (beta=-0.18, B=-0.07, SE=0.03, p=.04). Greater increases in dyadic variability from baseline to reunion play were also associated with lower infant cortisol reactivity (beta=-0.25, B=-0.09, SE=0.05, p=.02; Figure 2). Mutual positive engagement was not significantly associated with infant cortisol responses to the SFP (p's>.08).

Mother-infant dyadic variability significantly increased across the Still-Face Paradigm, potentially reflecting re-organization of behaviors to cope with stress. Notably, greater dyadic variability during reunion play and greater increases in dyadic flexibility from baseline to reunion play was associated with lower infant cortisol reactivity. Aligning with several theoretical frameworks, these findings suggest that a dyad's ability to flexibly re-organize behavioral patterns in response to environmental demands shapes infant regulatory abilities. These results advance understanding of how dyadic moment-to-moment mother-infant behavioral dynamics during relational stress contribute to infant biobehavioral regulation.

P3-C-480 - Linkages between fathers' trauma symptoms and their perceived quality of father-infant bonding: Moderating roles of fathers' marital satisfaction

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Details

While existing literature explores the impact of father-infant relationships on children (Mascheroni & Ionio, 2019), gaps persist in understanding the effects of paternal trauma exposure and marital satisfaction in shaping these impacts. Our study investigated how paternal trauma experiences shape interactions with infants and how marital satisfaction influences potential adverse effects, contributing to a more comprehensive understanding of father-infant relationships.

The present study included 168 first-time fathers in a randomized clinical trial of co-parenting adaptation intervention across the infants' first year. The data, gathered at 1, 3, 6, and 12 months postpartum, encompassed responses from fathers who completed surveys at each point. These surveys included the civilian post-traumatic stress disorder (PTSD) Checklist for DSM-5 (PCL-5; Weathers et al., 2013), the Couples Satisfaction Index (Funk and Rogge, 2007), and the Postpartum Bonding Instrument (PBI; Brockington et al., 2001). The PBI's three distinct dimensions of bonding included anger and restrictedness, lack of affection, and rejection and fear (Ohashi et al., 2016).

Given the repeated measures nested within individuals, our primary analyses utilized multilevel modeling. Trauma symptoms and marital satisfaction were employed as time-varying predictors in our models, allowing us to distinguish between within-person and between-person differences. Findings (Table 1) revealed that elevated levels of trauma symptoms, compared to fathers' cross-time average, were associated with increased rejection and fear in fathers toward infants. Furthermore, both lower average and decreased (relative to fathers' cross-time average) levels of marital satisfaction were associated with heightened anger and restrictedness and lack of affection toward infants.

Moreover, significant between-person marital satisfaction X infant age interactions predicted all three outcomes. Specifically, fathers with lower average marital satisfaction demonstrated increased bonding disorder toward their infants at 1, 3, and 6 months, but not at 12 months. Additionally, significant three-way interactions at the within-person levels of trauma symptoms, marital satisfaction, and infant age predicted all three outcomes. Specifically, regarding fathers' feelings of rejection and fear toward their infants (Figure 1), heightened levels of trauma symptoms, compared to fathers' own cross-time average, were linked with increased rejection and fear at 1, 3, and 6 months, but not at 12 months. This association was stronger when fathers' marital satisfaction decreased compared with when marital satisfaction increased. Conversely, when fathers experienced increased marital satisfaction, those with heightened levels of trauma symptoms, relative to their cross-time average, reported reduced feelings of rejection and fear toward their infants at 1, 3, and 6 months, but not at 12 months. The same pattern emerged for the other two outcomes, but only when fathers experienced decreased marital satisfaction compared to their cross-time average.

Overall, this study emphasizes the intricate relationship between trauma symptoms, marital satisfaction, and paternal perceptions toward infants. It suggests that fathers' marital satisfaction serves as a protective factor, mitigating the negative impact of trauma symptoms on the perceived quality of infant-father bonding during the first year of life. This underlines the significance of not only individual factors but also the contextual role of marital satisfaction in shaping paternal bonding and emotional responses to infants.

P3-C-481 - Influence of maternal depression on infant nighttime interaction and feeding

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Details

Introduction.

Maternal depression can have detrimental effects on mothers and babies in the early postpartum and beyond. Maternal depression has been linked with 1) elevated infant night waking (Teti & Crosby, 2012) and 2) exclusive formula feeding of infants (Chih et al., 2021), which is associated with an increased risk for obesity (Wang et al., 2017). Mechanisms underlying these associations, however, are unclear. This study examines mothers' depressive symptoms prenatally and in the early postpartum and their predictive links with observed interactions between mothers and their babies during the night around sleep and eating.

Methods.

This study (n = 81) draws from a larger, federally funded longitudinal study, SIESTA-Family Foundations, following first-time parents and their infants beginning prenatally and across the first year postpartum. Mothers reported their depressive symptoms during the 3rd trimester of pregnancy and again at 1- and 3-months postpartum (Beck Depression Inventory; Beck, 1961). Using 30-second interval sampling, overnight video captured interventions made by parents to infants in response to infant states of asleep, awake and not distressed, and awake and distressed. Duration and frequency of breast and bottle feeding were also assessed. Correlational analyses evaluated the association between mothers' depressive symptoms and maternal interventions with the infant in response to infant state of arousal and between mothers' depressive symptoms and infant bottle vs. breast feeding frequency. Further, correlations between depression and ITSEA (Infant-Toddler Social and Emotional Assessment; Carter & Briggs-Gowan, 2005) measurements of eating regulation at 12 months were assessed.

Results/Discussion.

This study found significant positive correlations between severity of maternal depressive symptoms and intervention to infants' non-distressed states in the early postpartum (Table 1). Prior work (Teti & Crosby, 2012) suggested that "unnecessary" maternal interventions to non-distressed infant arousal states during the night (e.g., when infants are asleep or awake but not distressed) may function to disrupt infant capacities for self-regulation. It is thus of value to see that depressive symptoms as early as the prenatal period predicted unnecessary interventions to the baby in the postpartum, which may lead to problems in eating regulation later on in development. These results can inform interventions designed to promote greater awareness in mothers experiencing depression that unnecessary nighttime interventions with infants can be detrimental to their infants' ability to develop healthy regulation of sleep and eating. Additionally, the present study found that mothers who reported prenatal depressive symptoms fed their infants significantly more by bottle than by breast (Table 1). Previous research shows that breastfeeding provides unmatched benefits (Binns et al. 2016; Hetzner et al. 2009), and so understanding this can prompt depressed mothers to breastfeed, when able. Lastly, our findings

Back to top

revealed a positive correlation between maternal depression (prenatally and at 1, 3 months), and the ITSEA eating subscale measured at 12 months, which indicates that poor eating regulation can be an undesired longer-term consequence of early maternal depression (Figure 1).

Conclusion.

Future research is necessary to examine real-time parent-child interactions and elucidate mechanisms to prevent sleep and eating dysregulation in infants. Implications for interventions will be discussed.

P3-C-482 - Maternal ambivalence about overprotective parenting with toddlers

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Details

Overprotective parenting behavior during the toddler years is a known predictor of social withdrawal and anxiety outcomes, not only later in the toddler period, but also later in child development (Bayer et al., 2006; Kiel & Buss, 2010). Overprotection warrants particular attention in toddlerhood, a period characterized by developmental tasks of gaining mastery of the environment and attaining independent emotion regulation skills. Little is known about parents' own evaluations of, or attitudes about, these behaviors. Ambivalent attitudes, reflecting a mix of positive and negative evaluations (Armitage & Conner, 2000), may reflect different motivations than purely positive or negative attitudes for engaging in overprotective parenting. Understanding parent attitudes about overprotection in toddlerhood could augment theory on the development of overprotective parenting and the parent-toddler dynamics relevant to toddlers' outcomes. To this end, the current study examined maternal anxiety and emotion regulation (emotional non-acceptance, distress intolerance, experiential avoidance) and toddler dysregulated fear and anxious behaviors as correlates of maternal ambivalence about overprotection, derived from a person-centered approach.

The current study tested relations in a sample of 140 mothers and their 2-year-old children (39% female), recruited for socioeconomic diversity. Each dyad completed a laboratory visit that facilitated the observation of maternal overprotective behaviors and toddler dysregulated fear. Mothers completed the Attitudes about Parenting Strategies for Anxiety survey (Kiel et al., 2019), from which ambivalence was derived. Mothers self-reported their anxiety and emotion regulation across multiple, well-validated measures. Mothers completed the Infant-Toddler Social Emotional Assessment (Carter & Briggs-Gowan, 2000) for a measure of toddler anxious behaviors.

Latent profile analysis identified a group of mothers expressing ambivalence about overprotective parenting (n = 72), as well as groups expressing uniformly positive (n = 34) and uniformly negative (n = 19) attitudes (Figure 1). A one-way ANOVA suggested group differences in observed overprotection F(2,

113) = 3.55, p = .032, ηp2 = .059, with the ambivalent group showing significantly more than the negative attitude group (Cohen's d = 0.87). ANOVAs also demonstrated group differences in maternal and toddler correlates of attitudes. The positive attitude group demonstrated higher maternal anxiety (F[2, 121] = 4.37, p = .015, ηp2 = .067) than the negative group (Cohen's d = 0.70), and the ambivalent group had toddlers with higher dysregulated fear (F[2, 113] = 3.68, p = .028, ηp2 = .061) than the negative group (Cohen's d = 0.64). No group differences emerged for maternal emotion regulation or mother-reported toddler anxious behavior.

Thus, the ambivalent and positive attitude group differed from the negative attitude group in unique ways, but they were rarely different from one another. Results are consistent with the idea that mothers who are ambivalent about overprotective behavior may engage in it for child-directed motivations, while mothers evaluating overprotection more positively may engage in it because of their own anxiety. Maternal ambivalence about overprotective parenting has implications for both the development of and interventions for anxiety in early childhood, given its relevance to overprotective parenting and mother and toddler characteristics related to risk.

P3-C-483 - Findings from a 2-year cohort of children born during the pandemic in Brazil (2021-2023)

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Details

Introduction: The pandemic has drastically changed the way of life of families around the world, increasing stress, anxiety, and depression, inclusive among children and adolescents. For children born during the pandemic, it also brought uncertainty regarding the long-term effects of gestational exposure to SARS-CoV-2, especially its impact on child development and behavior. Although there is little evidence of the SARS-CoV-2's direct effects, the late and indirect effects on child development still need investigation. **Objective:** To describe the findings of a 2-year follow-up of children born in Brazil during the pandemic concerning child development and behavior and family risk factors. **Methods:** It is a prospective cohort with a non-probabilistic sample of 603 children recruited from a serologic survey performed in five cities in Southeastern Brazil (April to August/2021), conducted during the routine neonatal screening to investigate the prevalence of SARS-CoV-2 IgG antibodies in a random sample of 1900 newborns and their mothers. It allowed us to identify children exposed and non-exposed to the virus in the gestation. All seropositive dyads were invited to participate in the 2-year follow-up. An equivalent number of seronegative dyads were sorted to be the control group. Mothers remotely answered interviews to characterize the sample (1 month-old) and to screen for child development and

behavior problems and families' risk factors (6, 12, 18, and 24 months-old), using the Survey of Wellbeing of Young Children (SWYC-BR). In-person assessments took place when children were 12 and 24 months old, using the Bayley III Scales. Data was described using absolute and relative frequencies. We calculated the mean prevalence of children with positive screening for SWYC-BR or abnormal results in Bayley III during the 2-year follow-up. **Results:** Table 1 shows the characteristics of the sample at the recruitment. Based on the serological survey and study design, 44.5% of children were exposed to SARS-CoV-2 during gestation. Table 2 displays the study's main findings, highlighting the epidemiological moment of the pandemic in the study's region. The mean prevalence of suspected developmental delays (SWYC-BR) was 31%, which was higher in the 18-month screening. Almost half of the children were suspected of behavioral problems, with a higher proportion in the first-year assessments. Children suspected of developmental delays, behavioral problems, and difficulties with social interactions represented 10% of the sample, indicating a high-risk group for developmental disorders. All family risk factors were more prevalent in the first-year interviews. Food insecurity, suspected maternal depression, and alcohol/drug abuse at home were reported by 19, 14, and 9% of mothers, respectively. Considering both Bayley III assessments, 23% of children were delayed in at least one domain. The language was the most affected domain (19%). **Conclusions:** The mean prevalence of suspected developmental and behavioral problems and family risk factors was slightly higher than in studies conducted before the pandemic in Brazil. Nevertheless, the proportion of children with multiple positive screenings suggests that only a few of them are at a high risk of developmental disorders. The decreasing prevalence of family risk factors over time possibly reflects the pandemic initial socioeconomic impacts, with a slow recovery in the last months. A high proportion of children with language delay may be related to the social distancing period. Next, we will analyze the effects of gestational exposure to SARS-CoV-2 and its interaction with families' context on children's developmental trajectories.

P3-C-484 - Impact of prenatal group social support on postpartum depression and emotion dysregulation

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Details

The ability for mothers to appropriately regulate emotions during the postpartum period is essential for optimal infant outcomes. Sameroff(2009) suggested that infants and mothers have a transactional relationship, where one may influence and contribute change in the other over time. When mothers have difficulty regulating emotions, interactions become negative and stressful for both infants and mothers(Bailes&Leereks,2022). Maternal emotional dysregulation has been linked with a variety of compromised parenting behaviors and infant maladjustment, including lower maternal sensitivity when responding to infant distress, and associated with infant attachment disorganization and behavior problems(Leerkes, et.al.,2020).

Maternal depression has also been linked to compromised parenting, leading to disruptions in emotional functioning and thinking, and incorrect or lack of responsiveness to infant needs. It is known that mothers with elevated depressive symptoms are at greater risk for emotion dysregulation(Carona

et al.,2022). However, what is not known is if mothers who suffer from elevated postpartum depression and have an increase in emotion dysregulation, could benefit from a standardized prenatal group social support program, *CenteringPregnancy*, that focuses on the transition to parenthood, including relationship building, and an increase in parenting skills. *CenteringPregnancy* could provide strategies for regulating emotions by empowering pregnant people with education and active engagement with other pregnant people. Accordingly, **we hypothesized that a)**there is a direct effect between maternal depression and maternal emotional dysregulation, where mothers with higher depressive symptomatology will have higher emotion dysregulation; **b)**there is a direct negative effect between *CenteringPregnancy* participation and emotion dysregulation, and **c)***CenteringPregnancy* will moderates the relationship between postpartum maternal depression and maternal emotion dysregulation.

This is a preliminary analysis on an ongoing,study that is actively recruiting participants from obstetric-gynecologist practices in the southeast. Data was collected during pregnancy(15weeks) and the 6-weeks postpartum OB visit(seeTable1). Participants(N=81) self-reported the Edinburgh Postnatal Depression Scale(EPDS) to collect depressive scores, and the Difficulties in Emotion Regulation Scale(DERS) to capture measures on emotion regulation problems. Participants self-selected into either *CenteringPregnancy*(N= 30) or in care-as-usual(N=51) after their first OB appointment. Data collection for this project is ongoing, and will be reanalyzed in several months to account for a larger sample size.

Multiple regression analysis was used to test if maternal depression and participation in *CenteringPregnancy* significantly predicted emotion dysregulation during the postpartum period. The overall regression model was statistically significant($R2= 0.40$; $p<0.001$; seeFigure1). It was found that postpartum depression significantly predicted emotion dysregulation during the postpartum period(Results also indicated that participating in *CenteringPregnancy* predicted lower emotion dysregulation during the postpartum period, however, there was no significant effect modification for mothers with depression in *CenteringPregnancy* on emotional dysregulation during the postpartum period. For mothers at risk for postpartum depression and emotion dysregulation, the *CenteringPregnancy* group social support model may be a good therapeutic intervention for facilitation of mental health screening, and provide group social support to promote positive emotion regulation strategies for optimal interaction between mothers and their infants.

P3-C-485 - Negative reactivity and amygdala volume at age 4 months: The role of maternal anxiety

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Details

The amygdala is a region of the brain central to processing salient stimuli. While we still know relatively little about the factors that impact amygdala development in infancy, some studies have shown that amygdala size is related to negative reactivity (a temperament characterized by novelty-evoked distress)

and exposure to maternal anxiety (Filippi et al., 2021; Korja et al., 2017). Even so, these associations have proven inconsistent. Negative reactivity and maternal anxiety are both potent risk markers for developing anxiety. However, no study has evaluated the relation between negative reactivity, maternal anxiety, and brain development. This project aims to clarify the relations between negative reactivity, maternal anxiety, and amygdala volume at age 4 months.

To do so, we made use of data from a longitudinal MRI study of infant temperament (n=111). A total of 53 infant–mother dyads in the study had high-quality structural MRI data at 4 months (M_{age} = 4.8 months, 47% female). This MRI data was processed using Infant FreeSurfer (Zöllei et al., 2020), an automated tool that segments the infant brain and provides volume estimates. Negative reactivity was assessed via an observational assessment (Calkins et al., 1996; Fox et al., 2001). Infant affect (positive and negative) and motor reactivity were coded to calculate a composite negative reactivity score. Maternal anxiety was measured at 4 months using mothers' total score on the Beck Anxiety Inventory (BAI; Beck et al., 1988).

Regression analyses evaluated associations between negative reactivity, maternal anxiety, and right and left amygdala volume. All models controlled for total brain volume, infant sex, and infant age at MRI and corrected for multiple testing (Bonferroni α = .05/2). Results indicated a significant interaction between reactivity and maternal anxiety on left amygdala volume (β = -0.465, p = .0315; Adjusted R^2 = .349, F(6, 46) = 5.65, p < .001; See Table 1). Specifically, there was a positive association between negative reactivity and left amygdala volume among infants with mothers who had low levels of anxiety (BAI scores ≤ -0.76 SD below the mean). Thus, at low levels of maternal anxiety, infants with greater negative reactivity exhibited *larger* left amygdala volume (See Figure 1). There was no significant association between reactivity and left amygdala volume at high levels of maternal anxiety.

The present results demonstrate that maternal anxiety moderates the association between infant negative reactivity and amygdala volume. Future research examining these associations longitudinally and following treatment of maternal anxiety would provide new insight into the complex interplay between the infant brain, behavior, and environment.

P3-C-486 - Maternal mental health and mother-infant physiological synchrony in everyday real-world settings

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Details

PRE-REGISTRATION SERVER [https://doi.org/10.17605/OSF.IO/KGST3]

Introduction

There is substantial evidence that maternal mental health can disrupt mother-infant synchrony. Maternal depression is associated with reduced engagement in maternal behaviors, such as affect,

touch, and gaze (Feldman, 2007). By contrast, anxious mothers tend to exhibit *increased* maternal behaviors, such as vocalizing and smiling (Feldman, 2007). Most existing work suggests that in cases of maternal anxiety and depression these behaviors are not contingently timed with infants' state, leading to decreased behavioral and physiological synchrony relative to healthy controls (Feldman, 2007; Granat, et al, 2017). Recently however, Smith et al (2021) utilized wearable physiology sensors to examine mother-infant arousal synchrony in natural home settings over 24-hours. Results showed that more anxious mothers exhibited *stronger* physiological synchrony with infants and heightened reactivity to fluctuations in infant arousal.

These findings differ from those conducted in laboratory settings, suggesting that the impacts of maternal mental health on physiological synchrony may manifest differently in ecologically valid everyday settings. Gold-standard assessments of mother-infant interactions likely constrain variability and timing of everyday arousal regulation behaviors, including proximity and touch (Micheletti et al, under review). However, due to the surprising direction of this effect, a replication is warranted. Additionally, given the established differences in synchrony between anxious and depressed mothers and their infants, we aim to expand these results to mothers experiencing depressive symptoms.

Objective

To replicate and expand on key findings from Smith et al (2021) to determine how maternal anxiety and depression symptoms moderate mother-infant physiological co-regulation in ecologically valid settings.

Methods

Mother-infant dyads (n = 87) were recruited in the context of a broader study leveraging wearable sensors to measure mother and infant behavior in the home. Of these, n = 53 dyads have mental health data, ECG, and auditory data. Infants averaged 3.9 months of age (SD = 2.2, range = 0.9-10.6 months). Each dyad recorded up to 72 hours of synchronized audio (LENA) and heart rate sensor (chest worn Movisense Mov3) data over one week (*figure 1*). Occurrences of infant crying were annotated from LENA audio recordings, and daily reports of anxiety (GAD-2) and depression (PHQ-2) symptoms were captured via mobile surveys.

Data Analysis Plan

Following Smith et al (2021), we will use cross correlations to test the hypotheses that infant-mother physiological synchrony will be 1a) greater in dyads with more anxious mothers relative to non-anxious mothers, and 1b) lower in dyads with more depressed mothers relative to non-depressed mothers. Following Madden-Rusnak et al (2023) we will use event-related analyses to test the hypotheses that 2a) more anxious mothers will show greater autonomic reactivity to infant crying events relative to non-anxious mothers, and 2b) more depressed mothers will show less autonomic reactivity to infant crying relative to non-depressed mothers.

A median split will differentiate high/low anxiety symptom groups using GAD-2 mean scores. Given that more than half of our sample showed little-to-no depression symptoms across data collection (*figure 2a*), we will use a threshold of at least 2 on PHQ-2 mean scores to differentiate high/low depression symptom groups.

P3-C-487 - Exploring the impact of maternal adverse childhood experiences on parenting interactions and mental health in toddlers.

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Details

Introduction
Early childhood is a crucial stage for individual development, where primary caregivers play a fundamental role in fostering development (Shonkoff & Fisher, 2013). The influence of caregivers on child development needs to be more broadly explored to devise effective interventions (Madigan et al., 2015). This analysis has to include parenting interactions, understood as specific parental behaviors within dyadic interaction that foster development (Roggman et al., 2013). Additionally, recent studies have focused on the role of Adverse Childhood Experiences (ACEs) in caregivers. In Chile, the National Survey on Childhood Sexual Abuse and Adversities (CUIDA, 2022) reported that 55% of the adult population experienced four or more ACEs. This holds significance as higher exposure to ACEs during childhood has been associated with inadequate parenting styles in those affected, which in turn negatively impact their children's development and, particularly, their mental health (Racine et al., 2023).
Consequently, while the parent-child relationship could serve as a channel for transmitting adverse experiences, it also offers an opportunity to break the cycle of vulnerability. This could be achieved through interventions targeting the challenges faced by mothers who have experienced ACEs. To achieve this, additional evidence regarding the impact of adverse childhood experiences on later parenting interactions and child mental health is necessary. Thus, this study aims to investigate the relationship between mothers' adverse childhood experiences and their parenting interactions and their children's mental health. Our hypothesis are: a) The group of mothers with a higher level of ACEs will exhibit poorer parenting interactions compared to the group with low ACEs.
b) The group of mothers with a higher level of ACEs will have children with poorer mental health compared to the group with low ACEs.

Methods
We present data from a sample of 194 mothers and their children. A subsample of 10 mothers was selected for analyzing parenting interactions. Children are between 2 and 4 years old and attend public early childhood education centers in Santiago, Chile.
Mothers completed an online survey with information regarding sociodemographic data, ACEs, mental health, and child's mental health. After completing the questionnaires, they recorded a five-minute video of free play with their children. The ACEs were measured with the ACE-IQ (WHO, 2011). The quality of parenting interactions was measured by coding the videos using the Spanish version of the PICCOLO observational tool (Roggman et al., 2013; Vilaseca et al., 2019). Finally, the child's mental health was measured using the SDQ (Goodman, 1997).

Results
There are statistically significant differences in the total score of the SDQ between the high and the low

ACEs groups, showing that the high ACEs group has higher scores regarding child symptomatology (W = 3048, p-value = 0.032). Correlational analysis show that maternal ACEs are associated with the child's mental health, specifically with the hyperactivity subscale (r=0.22, p=0,002) and with the SDQ total score (r=0,15, p=0,034). Preliminary analysis show differences in the PICCOLO scores, being lower for the high ACEs group.

P3-C-488 - The bidirectional relations between the maternal and infant gut microbiome and behavior during the first year of postnatal life

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Details

Introduction: How the gut microbiome relates to behavioral development during infancy, including potential bidirectional relations between mother and child, remains poorly understood.

Hypotheses: We hypothesized that the infant microbiome would be shaped by maternal gut microbiome composition and maternal depression, and that individual differences in the infant microbiome would be associated with behavioral temperament.

Study Population: One hundred and twenty one mother and infant dyads were included in the present study (N = 514 stool samples; N = 89 White; N = 76 Mothers obtained a Bachelor's Degree or higher; time points at ages: 1 month, 7 months, and 14 months).

Methods: Using metagenomically sequenced stool samples and behavioral questionnaires (Infant Behavioral Questionnaire, Early Childhood Behavioral Questionnaire, and Edinburgh Postnatal Depression Scale), we examined within-person and between-person (mother-infant dyad) associations between the gut microbiota and behavior across the first year of postnatal life.

Results: Infants, but not postpartum mothers, exhibit group-level increases in gut microbiome taxa diversity (Chao1) with age (see Figure 1). In addition, our analysis revealed several longitudinal associations between gut microbiome taxa diversity (Chao1) and behavior for both mother and infant (see Figure 2). Conditional inference random forest analyses showed that maternal postpartum

depressive symptoms were associated with a series of infant (e.g., *Holdemanella*, and *Ruminococcus*) and maternal (e.g., *Mobiluncus*, *Bifidobacterium,* and *Lactobacillus*) gut taxa and functional terms (e.g., antibiotic resistance genes, gene ontology terms, and virulence factors), indicating unique bidirectional relations between infant-maternal microbiomes. However, neither infant nor maternal taxa were predictive of infant behavioral temperament across the first year postnatally.

Conclusions: Our findings provide evidence for complex bidirectional relations between maternal and infant gut microbiomes and behavioral traits, identifying unique biological signatures that may shape infant behavioral traits and maternal mental health.

P3-C-489 - Maternal sleep and parenting quality during the first six months predict infant regulatory processes and toddler socioemotional outcomes.

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Details

Infant socioemotional development across the first two years of life is shaped by both proximal and distal ecological factors. Among these, parenting quality and parent regulatory abilities are primary contributors to infants' ability to self-regulate (Wong et al., 2022). Maternal sleep, a marker of regulation, has been linked to parenting quality (King et al., 2022), which in turn has been linked to infant outcomes (Bai et al., 2022). In turn, infant regulatory abilities related to circadian rhythmicity, such as sleep and cortisol, often become consolidated after 6 months of life (Henderson et al., 2011; Wong et al., 2022) and have been associated with socioemotional outcomes (Cui et al., 2018).

However, less is known about how infant regulatory abilities mediate interlinkages between parent processes during early infancy and later infant outcomes. The current study examines these linkages and the degree to which they predict infant sleep and stress reactivity during sensitive periods of development during the first two years. It was hypothesized that better regulated maternal sleep would predict better parenting quality during the first 6 months postpartum, which in turn would predict better infant sleep and lower cortisol output in infants at 9-12 months of age, and fewer socioemotional problems during toddlerhood.

The current study utilizes a multi-method design and longitudinal data from 168 dual-parent socioeconomically diverse families. At 1,3, and 6 months, maternal sleep was assessed using wrist-worn actigraphy for up to 8 consecutive nights to capture objective assessments of sleep duration, quality, and variability. During the same period, trained observers scored bedtime parenting quality from video observations of a single evening at each timepoint to assess non-hostility, non-intrusiveness, structuring, and sensitivity using the Emotional Availability Scales (Biringen et al.,1998). Infant sleep (9 – 12 months) was assessed using an actiwatch secured with Velcro on the infants' calves. Infant salivary cortisol (9 – 12 months) was determined as area under the curve based on four samples collected on a single day during the same week as sleep assessments. Mothers completed the Infant Toddler Social and

Emotional Assessment Questionnaire (Carter & Briggs-Gowan, 2006) when the child was 18 and 24 months to report on internalizing, externalizing, dysregulation, and competence domains. Mean values across timepoints were correlated and composited for each variable of interest.

Path analyses were utilized to identify putative paths of influence. A significant path emerged between maternal parenting quality at 1-6 months predicting infant sleep variability at 9-12 months, which in turn predicted infant internalizing problems at 18-24 months (Figure 1a). Upon inclusion of maternal sleep in the model, more variable maternal sleep predicted lower emotional availability. This second path of influence approached significance. In which greater variability in mothers' sleep duration predicted poorer maternal parenting quality, which in turn was associated with greater sleep variability in infants and greater internalizing problems (Figure 1b). A similar pattern of effects emerged for dysregulation outcomes (not depicted).

Additional analyses will consider other sleep and cortisol variables as markers of regulation for mothers and infants to further identify longitudinal paths of influence.

P3-C-490 - Maternal perinatal stress, breastfeeding and child neurodevelopment: Associations with the infant microbiome in an African American sample

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Details

BACKGROUND. Health disparities begin *in utero* and continue after birth. Compared to White infants, African American infants are more likely to evidence neurocognitive delays, a disparity that persists or worsens across development, even when controlling for socioeconomic status. Increased chronic stress exposure during pregnancy and a differential susceptibility to maternal perinatal stress are hypothesized to significantly contribute to these developmental disparities. Rates of breastfeeding are also lower in African Americans, potentially reducing protective nutritive influences on children's outcomes. Recently, the gut microbiome has been suggested as an important link between stress exposure and neurodevelopment, but microbiome studies focused on African American infants are scarce.

METHODS. Participants in this study included two overlapping samples. The first sample consisted of 79 African American mothers (aged 18-35 years) and their infant children. During pregnancy and infancy follow ups, mothers in this sample reported on life stressors and perceived stress symptoms. Breastfeeding status was ascertained, and infant stool was collected at one month and three months of age. The stool was later batch assayed using 16S sequencing methods to assess levels of gut microbiome taxa. The second sample consisted of 114 African American mothers (aged 18-35 years) and their infant and toddler children. Infant stool from 6 to 24 months of age was assayed to assess gut microbiome taxa levels, and mothers reported children's behavioral outcomes at two and three years of age on the Child Behavior Checklist. In the first sample, regression models were used to examine the effects of maternal stress on Lactobacillus and Bifidobacterium taxa, and to test breastfeeding as a potential moderator. In the second sample regression models were used to test associations between Lactobacillus and Bifidobacterium taxa and child behavior problems. All analyses adjusted for maternal education,

maternal age, maternal prenatal BMI, parity, mode of delivery, offspring sex, visit time point, and offspring age at stool collection.

RESULTS. In the first sample, higher levels of prenatal stressful life events were associated with lower levels of infant gut Bifidobacterium (p<.05), and breastfeeding status interacted with maternal reports of perceived stress during pregnancy and the postpartum to predict Bifidobacterium levels ($p<.05$) such that negative associations between maternal perceived stress and Bifidobacterium were attenuated in cases where infants were currently being breastfed. Contrary to our hypothesis, maternal postpartum perceived stress levels were associated with higher rather than lower levels of Lactobacillus (p<.001). In our second sample lower levels of Bifidobacterium and higher levels of Lactobacillus predicted increased behavior problems in children (p<.05).

CONCLUSIONS. Results reveal associations between maternal stress, the infant gut microbiome and child neurodevelopment, some of which suggest a protective role for infant breastfeeding. Bifidobacterium findings were consistent with the broader literature which considers these taxa to be protective and health promoting. In contrast, our findings concerning Lactobacillus were divergent from the broader literature, suggesting potentially unique microbiome related pathways between maternal stress and child neurodevelopmental outcomes in African American families.

P3-C-491 - Asymmetry of alpha coherence in infants of depressed mothers

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Details

Background: Prior research on neurophysiology of infants of depressed mothers has primarily focused on EEG power and asymmetry (Diego et al., 2010; Goodman et al., 2020; Hardin et al., 2021). Infants of depressed mothers tend to demonstrate greater right frontal asymmetry, which has been described as a moderator or mediator of psychopathology, due to its association with behavioral withdrawal, negative affective style, depressive symptoms, and childhood adversity. Despite considerable investigative pursuits into asymmetry in infants of depressed mothers, alpha coherence, and the hemispheric patterns of coherence, have not seen the same level of examination, despite the possibility that connectivity measures may also demonstrate risk and may better generalize. This study aims to compare the asymmetry of alpha coherence in infants of mothers with different levels of depressive symptoms and analyze asymmetrical tendencies across infant ages. **Hypothesis:** Infants with mothers who have more depressive symptoms will demonstrate lower alpha coherence across both hemispheres compared to those infants with mothers who have lower levels of depressive symptoms. Exploratory analyses will compare left and right hemisphere coherence values as well as examine alpha coherence asymmetry between groups and across ages.

Method: EEG was collected from 222 mother/infant dyads from frontal, central, parietal and occipital sites and analyzed in all intra-hemispheric pairs in left and right hemispheres, with 6 pairs of short and long connections for each hemisphere. Age groups of participants were as follows: 1-month-olds (N=49, M=37.75 days; SD=5.48), 3-month-olds (N=64, M=95.29 days, SD=11.04), 6-month-olds (N=45,

M=202.50 days, SD=17.77), 9-month-olds (N=30, M=267.45 days, SD=24.47) and 12-month-olds (N=34, M=394.67 days, SD=31.97). Participants in this study comprise a non-clinical sample of mothers, depressive symptoms measured on the Center for Epidemiological Studies Depression Scale (CES-D: Radloff, 1977). Coherence asymmetry will be analyzed by subtracting coherence in left regions from the coherence at right regions and then dividing by their sum (Imperatori et al., 2019).

Results: Preliminary data demonstrate significant effects of maternal depression on infant coherence between frontal-occipital regions (*Fs*=4.36 to 5.40, *ps* < .05) and frontal-parietal regions (*Fs*=5.58 to 8.59, *ps* < .05). Overall, differences were in the right hemisphere (in F4/P4 pairs) and were generally characterized by lower coherence in infants whose mothers had higher depression. Normative samples demonstrated age-related decreases in coherence, (*F*=14.368, *p*<.001), but infants of more highly depressed mothers did not show consistent age-related patterns, (*p* > .05). Future, pre-registered analyses include comparing alpha coherence asymmetry patterns between infants of mothers with higher and lower levels of depressive symptoms.

Conclusion: Findings suggest dynamic developmental changes in alpha-band EEG coherence and that maternal depressive symptoms affect age-related development in infancy. Registered analyses are designed to uncover whether alpha coherence asymmetry (a measure of functional connectivity within each hemisphere) provides evidence of greater cortical activity in right relative to left regions across development, a pattern associated with internalizing symptoms, delayed regulation and withdrawal behaviors.

P3-D-492 - Exploring the Infant Talker Bias using remote testing methods

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Details

Remote testing can broaden the impact of our work by bringing a more diverse and representative subject pool into our research. It also presents new challenges that vary with infant age and research focus. The present study explores the feasibility of measuring infant auditory preference using a remote asynchronous task. We focus on the recent finding that infants prefer to listen to other infants' vocalizations, aka the Infant Talker Bias (Masapollo et al., 2016; Polka et al., 2022).

Here we attempt to replicate this finding by implementing a sequential preferential listening task on the Lookit platform. We also designed the study to probe for new insights into what underpins infants' preference for infant speech by measuring listening preference across a wider age range and assessing other responses that infants display during the task.

To assess the Infant Talker Bias on Lookit, we synthesized "ee" and "aw" vowels that simulate an adult and an infant talker and presented them to English-learning 4 to 12-month-olds in a preference task with 8 trials. On each trial the same vowel was played 10 times while a simple moving image was displayed on the monitor and the infants' face was recorded over the webcam. Each trial was 14-s long

(not infant-controlled). Different vowels simulating different voices were presented across trials (two woman “ee” trials; two woman “aw” trials; two infant “ee” trials; two infant “aw” trials.)

To date, 90 infants have entered the study. The standard dependent variable in this task is looking time. Given the challenges associated with looking-time based procedures in on-line tasks, we also explored other responses that may help us gauge infant preference in the remote testing context, including infant facial expressions and vocalizations. Here we report the exploratory findings from these supplemental measures. The presence and duration of infant vocalization was manually coded on each trial. Infant recordings were also analyzed using Baby FaceReader, which provides frame-by-frame automated analysis of facial movements indexed in facial action units. We analyzed three variables that are automatically derived using these action units – emotional valence, arousal, and happy expression.

This is the first study of its kind to use facial movement analysis to assess infant responses to speech and the first to test infant vowel-perception remotely (study preregistration is found at https://osf.io/nzde8). The findings will be informative in several ways. First, they may reveal novel analysis approaches that can provide a more robust and informative assessment of infant preference. They may also point to ways to optimize infant engagement and reduce subject attrition in the remote testing context. We will also learn about the potential utility as well as the current limitations and challenges associated with using facial analysis with infants in a remote testing environment.

P3-D-493 - Early word learning profiles and vocabulary development: a k-mean clustering approach

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Details

Children learn language at an incredible speed but there is high variability in their vocabulary development (Frank et al., 2021). Among other factors, this variability has been associated with differences between children in the processes that support word learning. For instance, children who are faster at processing words show faster vocabulary growth (Fernald et al., 2006), and children with larger vocabularies can better identify new referents (Bion et al., 2013) and learn new words (Samuelson et al., 2017). However, it is unclear how multiple word learning processes work together to support vocabulary development and create variability among children. The aim of this study is to: 1) simultaneously measure multiple word learning processes in individual children, 2) to identify groups of children with similar learning profiles, and 3) assess which combinations of word learning processes are associated with vocabulary size.

We used an eye-tracking task with 88 children learning British English, between 15 and 27 months of age (*M* = 20.45), simultaneously measuring children’s speed of word processing, word comprehension (including nouns, verbs and adjectives), novelty biases, referent selection and retention of new words. For each measure, we extracted a set of time coefficients: intercept (accuracy), linear term (processing speed), and quadratic term (fixation release; Mirman, 2008). Vocabulary was measured using the OCDI (Hamilton et al., 2000).

To group children with similar learning profiles, we applied k-means clustering (Astle et al., 2018) with four optimal clusters (Figure 1), determined using the silhouette approach. After applying Bonferroni corrections, we found differences across the four clusters for comprehension (easy nouns: intercept $\eta 2$ = 0.33, $p < .001$; quadratic $\eta 2$ = 0.30, $p < .001$; nouns varying in difficulty: intercept $\eta 2$ = 0.42, $p < .001$; linear $\eta 2$ = 0.26, $p < .001$; quadratic $\eta 2$ = 0.19, $p < .001$; adjectives and verbs: intercept $\eta 2$ = 0.21, $p < .001$), referent selection (novel: quadratic $\eta 2$ = 0.20, $p < .001$) and retention of new words (intercept $\eta 2$ = 0.21, $p < .001$; quadratic $\eta 2$ = 0.23, $p < .001$). Thus, children across the four clusters varied mostly in word comprehension accuracy, noun processing speed and release, fixation release during referent selection and retention, and in their accuracy remembering new words (Figure 2). They also varied in their productive vocabularies ($\eta 2$ = 0.25, $p < .001$), with cluster 3 containing children with the largest vocabularies (M = 261 words). Children under that profile showed higher accuracy (β = 1.11, p < .001) and faster speed of processing (β = 0.68, p = 0.040) in noun comprehension, as well as longer fixations during referent selection (β = 1.59, p < .001) and retention (β = 0.85; p = 0.010), compared to children from cluster 1 with smaller vocabularies (M = 122 words).

In summary, our data shows links between children's noun comprehension and speed of processing abilities, their skills while learning and remembering new words, and the size of their productive vocabulary. This suggests that those processes might work together and be optimal for word learning and vocabulary development.

P3-D-494 - #InstagramMoms: The role of Instagram use on mother-infant interactions

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Details

Mothers talk to their infants in highly exaggerated ways, and infants prefer infant-directed speech (IDS) over adult-directed speech (ADS, e.g., Bergeson et al., 2006; Fernald, 1985; Wang et al. 2017). Instagram has become a useful social medium for mothers to share pictures and videos of their children. However, an "invisible audience" could disrupt typical mother-infant interactions. In the case of Instagram, the mothers' conversational partner is virtual and non-interactive, which might be confusing for an infant learning language. The purpose of this study is to examine the role of Instagram in mother-infant interactions.

We have followed 14 mothers with public Instagram accounts whose infants were 5-12 months of age at the beginning of the study. Camera orientation, proximity of infant to mother, maternal language characteristics, infants' behavior, and environmental factors were measured. For each video, we recorded a general description of how the dyads are situated, eye contact, type of speech (IDS vs. ADS), proximity, and touch. We coded 10-26 videos for most mothers; two mothers were prolific posters for whom 40 and 86 videos were coded. The frequency of behaviors across categories was calculated across videos for each mother.

The following results were tabulated from a total of 247 videos collected over the course of 7 months. Mothers typically posted Instagram videos using the camera on the back of the phone with the infant in the camera's view and the mother holding the phone (64% of videos). Most of the remaining 34% of videos were filmed in selfie mode (using the front-facing camera). In 68% of videos, mothers and infants made eye-contact with one another, while in 17% of the videos no eye contact was made from the infant to the mother. In 12% of videos, there was no eye contact from the mother to the infant because they were looking at the phone. The infants are more likely to make eye contact with their mom behind the camera than when in selfie mode.

The mothers used IDS in 65% of the videos, while 16% used ADS only and 19% used both. Mothers held their child in 30% of the videos and touched their infants in 25% of the videos. In 45% of videos, the infants made vocalizations in response to their mothers' speech. Moreover, in 32% of the videos, the babies gave nonverbal feedback to the mother, while 30% had no feedback or vocalizations.

Overall, these results indicate that the Instagram videos are often filmed with the infant in the camera view and the mother behind the phone. Additionally, infants tended to make more eye contact with their mothers when the phone was not in selfie mode. The relatively low percentage of IDS (65%) and mother-infant eye contact (68%) suggests that active Instagram use by mother could potentially disrupt typical mother-infant interactions. Infants also tended to respond to mothers when they were using IDS, which suggests that these interactions could influence children's language development. Data collection is ongoing, and we are measuring characteristics of the children's language to determine if the Instagram mother-infant interactions predict later language development.

P3-D-495 - Voice familiarity and lexical-semantic activation: An ERP study in 14- and 18-month-olds

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Details

Developmental language studies have shown evidence of a lexical-semantic network in infants as young as 18-24 months of age (for a review see Wojcik, 2018). In the present study, we examined event-related potentials (ERPs) to determine whether a familiar voice facilitates access to the lexical-semantic network for 14- and 18-month-old infants. In particular, we measured the N400 - a negative-going ERP at around 400 ms post target word onset that is commonly observed for semantic incongruences, thereby indicating access to the lexical-semantic network (Kutas & Federmeier, 2011; Junge et al., 2021). Based on previous findings on the importance of familiarity in infant cognition, we expected to find greater N400 components for unrelated as opposed to related target words presented by a familiar as

opposed to an unfamiliar voice, in our spoken-word electroencephalography (EEG) paradigm.

We recorded the brain activity of 14-month-old (n = 26) and 18-month-old (n = 30) French-learning monolingual infants using EEG while they listened to the stimuli. Data were recorded from 128 electrodes of a Geodesic Sensor Net (GSN, NetStation EGI V2.0). Infants were familiarized with one voice for the seven days leading up to the experiment, through a procedure in which parents presented their children with audio-recordings of stories spoken by one of the two possible voices. Stimuli (audio recordings of 20 French nouns) were randomly presented in taxonomically related and unrelated pairs. All infants heard word pairs spoken by a familiar and an unfamiliar voice. Following findings from previous priming studies, the N400 time window was defined as 300 – 700 ms. We also defined an earlier time window, between 150 – 300 ms, to examine earlier effects, as has been done in previous studies. We conducted a repeated measures analysis of variance (ANOVA) with within-subjects factors of *Trial* (related, unrelated), *Familiarity* (familiar, unfamiliar), *Area* (frontal, parietal) and *Hemisphere* (left, right) and a between-subjects factors of *Age* (14 months, 18 months).

In the N400 time window, we found a three-way interaction between Trial, Familiarity and Age *(F(1,52) = 7.56, p=.008, np2=.12)*. In further ANOVAs, we analyzed the age groups separately. 18-month-olds showed an N400 effect over the left hemisphere, only for the familiar voice *(t(29) = 2.28, p = .030, d= .46)*. The 14-month-olds, however, showed a bilateral N400 only for the unfamiliar voice *(t(25) = 2.69, p=.012, d = .54)*, and no difference between trial types presented by the familiar voice. Our results show an N400 in both 14- and 18-month old infants, and suggest that the role played by voice familiarity in infant lexical-semantic processing may be age dependent.

P3-D-496 - Can bilingual exposure enhance other-race face recognition in infants?

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Details

Previous studies have demonstrated that 9- and 12-month-old infants can learn and recognize own-race faces when these are associated with their native language, but not when associated with a non-native language (Boisferon et al., 2021). Similarly, at these ages, infants show recognition memory for other-race faces when associated with non-native speech, but not with native speech (Clerc et al., 2022). These results confirm the strong link between face and speech perception during infancy. On the other hand, bilingual exposure during the first years of life affects audiovisual associations such as face-voice pairings (Levi, 2018; Orena, Polka, & Theodore, 2019), and enhances encoding of visual stimuli and sensitivity to referential cues (Singh et al., 2015; Yow & Markman, 2011). The current study aimed at 1) exploring the possible role of bilingualism in other-race face recognition, when associated with non-native speech, and 2) whether parent code-switching (CS) may play a role in this association. We tested 9- to 11-month-old Catalan or Spanish monolingual (20) and Catalan-Spanish bilingual (21) infants. Using the same procedure and materials as Clerc et al. (2022), infants were shown still photographs of an Asian face while audio was played in a non-native language. After this familiarization phase, the familiar

face and a novel one were displayed side-by-side for the recognition test. Proportion of total looking time toward the novel face was used as an indicator of novelty preference. Results revealed that, in line with Clerc et al., (2022), all infants exhibited recognition memory for the other-race face when familiarized with non-native speech [$t(40)= 3.150$, $p = .002$]. No difference between groups was observed [$t(38)= .476$, $p = .318$], with monolinguals showing a 54.5% novelty preference and bilinguals, a 56.2% one. However, when analyzing the data from all the experiment, a difference between groups was observed in total looking time to the screen, first in the familiarization phase [$t(39)= 1.845$, $p = .03$], and partially in the test phase [$t(39)= 1.582$, $p = .06$], with bilinguals showing less looking time (70% in the familiarization phase and 84% in the test phase) than monolinguals (79% in the familiarization phase and 91% in the test phase). This result deserves further exploration, as it might have implications for differences in attention patterns in bilingual and monolingual infants. Finally, using the parent code-switching (CS) questionnaire (Byers-Heinlein, 2013), infants were divided into three subsets, low CS (first and second quartiles, 0< CS< 7.5, N=13), medium CS (third quartile, 7.5< CS< 10, N=9), and high CS (fourth quartile, 10< CS<25, N=11). Preliminary results show that, while in the low and medium CS subsets novelty preference was not associated with CS, in the high CS condition, higher codeswitching was significantly correlated with higher face recognition [$r = .597$, $p = .02$]. Although not conclusive, this finding emphasizes the need to explore bilingual populations in detail as to allow for a more comprehensive analysis of performance.

P3-D-497 - German infants' discrimination of the English /æ/-/ɛ/ contrast: a cross-sectional and a longitudinal study

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Details

Many previous studies have shown that infants' vowel discrimination is characterized by asymmetries in perception, with vowel changes in one direction being easier to detect than in the opposite direction (e.g., Polka & Bohn, 1996). Two sources of these asymmetries were proposed: language-universal biases based on phonetic properties of the vowels (Natural Referent Vowel framework: NRV, Polka & Bohn, 1996, 2011) and the language-specific internal structure of the vocalic categories arising from linguistic experience (Native Language Magnet model: NLM; Kuhl, et al. 2008). Supporting the NRV, Polka & Bohn (1996) found that German-learning 6-8- and 10-12-month-olds discriminated the English /æ/-/ɛ/ contrast when the change was from /ɛ/ to /æ/ but not in the other direction. In contrast, the NLM would predict an asymmetry in the other direction as English /ɛ/ is more similar to a German vowel than English /æ/ is, which makes changes from /æ/ to /ɛ/ more salient. As Polka and Bohn (1996) tested only a small sample of a rather broad age, we tested the discrimination of this contrast with a larger sample size that was also better controlled for age. The study involved a cross-sectional approach with infants between 5 and 13 months and a longitudinal study in which the same infants were tested three times to investigate whether repeated exposure together with increasing language experience would affect infants' performance.
In the cross-sectional study, the discrimination for the /æ/-/ɛ/ contrast was tested with German infants at 5-6 (N = 37), 8-9 (N = 29) and 12-13 months (N = 30) using a habituation paradigm. Half of the infants were habituated with /æ/ and the other half with /ɛ/. During the test phase, infants were exposed to

both types of stimuli. Linear mixed-effects models revealed that 8-9- and 12-13-month-olds discriminated the contrast only when habituated with /ɛ/, while 5-6-month-olds did not, independent of the habituation condition. The asymmetric perception found for the 8-9- and 12-13-month-olds showed the same direction as found by Polka and Bohn (1996), although the listening preference for the habituated vs. non-habituated stimuli switched between the age groups.
In the longitudinal study, the infants tested at 5-6 months in the cross-sectional study were tested again at 8-9 (N = 23) and 12-13 months (N =18). Interestingly, the infants discriminated the contrast at both ages but only when habituated with /æ/, showing an asymmetry in the opposite direction than their cross-sectionally tested age-mates.
Overall, the results show a reversal in asymmetric perception depending on exposure. Infants exposed to the stimuli for the first time showed asymmetric perception aligning with the NRV. We propose that the reversal of the effect in the longitudinal group is an effect of increased exposure to the stimuli and the growing language experience such that /ɛ/ is recognized as the more typical German vowel and starts to act as a magnet. Taken together, the results contribute to ongoing discussions about the general trajectory of perceptual development and provide the first set of evidence of reversed asymmetry caused by experiment experience.

P3-D-498 - Infants' word segmentation abilities in spectrally degraded speech at 6 and 10 months of age

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Details

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Segmenting the continuous speech signal into word forms is a necessary prerequisite to learning words and their meanings. This ability emerges between 4 and 7 months of age, and infants rely on a variety of cues to accomplish this task, such as the prosodic, statistical, acoustic-segmental, and lexical information available in the signal. While these sources of information have received substantial attention in the literature, no study to date has investigated the role of auditory processing in segmentation, that is, of the specific physical acoustic properties of the signal necessary for successfully extracting words from fluent speech. When encoding speech, the auditory system is thought to extract the spectral components of the signal, modelled as a series of narrowband filters. Then, within each narrowband, the temporal components of the signal, i.e. the modulations in amplitude over time, are decomposed at two timescales: slower modulations, i.e., Amplitude Modulation (AM), and faster modulations, i.e., Frequency Modulation (FM). Since the auditory system is still maturing during infancy, the weight of these specific spectrotemporal cues might change during development.

In two experiments with French-learning 6- and 10-month-olds (n = 48 each), using the Headturn Preference Procedure, we examined the acoustic cues that allow infants to segment word forms from fluent speech. Infants were familiarized with passages containing a monosyllabic target word in French (e.g. */fø/ feu* "fire"), and then tested on their recognition of the familiar target versus a novel control word

(e.g. /bu/ *bout* "piece") presented in isolation. Test stimuli were presented in three blocks of 4 trials each. Stimuli consisted of natural speech stimuli that were acoustically degraded using two vocoders extracting AM and FM in either 8 or 16 spectral bands. In each vocoder, FM was replaced by pure tones in each band but original AM was preserved.

We fit linear mixed effects models. The model that best fit the data in Experiment 1 included only the fixed effect of Block, suggesting that the 6-month-olds were unable to segment the targets regardless of the number of spectral bands present in the signal (see Figure). Analysis of Experiment 2 yielded main effects of Familiarity (familiar vs. novel; p=.032), Block (p<.001), and their significant triple interaction with Spectral bands (8 or 16; p=.037). Posthoc analyses revealed that the 10-month-olds succeeded in recognizing the target in the 16 spectral band condition, and in the second block (p=.009).

Together, these findings suggest that 6-month-olds need FM cues for speech segmentation while 10-month-olds do not, although they need the AM cues to be present in a sufficient number of spectral bands (i.e. 16). This developmental change observed in infants' sensitivity to spectrotemporal cues coincides with an increase in their range of cues available for segmentation, which could allow them to compensate for the degradation of the signal.

P3-D-499 - Contingency enables the formation of social expectations about an artificial agent

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Details

During socially guided vocal learning, caregivers' contingent responses to infants' non-cry prelinguistic vocalizations constitute feedback, facilitating the formation of infants' expectations for vocalizations to elicit responses (Goldstein et al., 2009). Increased vocalization rate during the still-face paradigm is predicted by infant age and maternal contingent responsiveness in free-play, suggesting that experience builds expectations for the social efficacy of vocalizing (Elmlinger et al., 2023). Since infants' vocalizations typically elicit responses only from humans, contingency may indicate who to interact with and learn from. How plastic is the detection of social partners in infancy? Do infants use contingent responsiveness to determine what is and isn't a social partner? We used the vocal learning paradigm to assess infants' ability to learn from a non-biological interactive agent, a remote-controlled car.

Infants engaged with one of two agents, either a car or a human experimenter. During Baseline 1 (10 minutes) infants received contingent responses to their vocalizations from the agent at a rate determined by their caregiver's observed response rate. Agents responded by approaching the infant. In the Social Response period (10 minutes), the agent approached the infant and produced vowel sounds, either as a contingent response to vocalizations in the contingent car (CC) and human (CH) conditions, or on a yoked schedule in separate car (YC) and human (YH) conditions. In the No Response period (two minutes), the agent became unresponsive. In Baseline 2 (10 minutes), the agent returned to the baseline response rate.

We measured the rate and the directedness of infant non-cry vocalizations. We determined directedness based on infants' gaze and head direction. Paired-sample Wilcoxon tests revealed significant differences in vocalization rates between the Social Response and No Response period across all four conditions (Figure 1) (**CC:** (W=7, p=.0006, df=15); **CH:**(W=25, p=.015, df=16); **YC:** (W=13, p=.0005, df=14); **YH:**(W=1, p<.0001, df=15)).

Differences between conditions in vocal directedness were assessed for each period with Wilcoxon tests with Bonferroni corrections for multiple comparisons (Figure 2). During No Response, there was a significant difference in the proportion of agent-directed vocalizations between the CC and CH conditions (W=235, p=.002, df_CC=15, df_CH=16). CC condition infants produced a higher proportion (mean=0.277, sd=0.289) than CH condition infants (mean=0.0309, sd=0.0386). There were significant differences in the proportion of caregiver-directed vocalizations during No Response between the CC and YC conditions (W=56, p=.039, df_CC=15, df_YC=14). CC condition infants produced a lower proportion (mean=0.019, sd=0.0331) than YC condition infants (mean=0.243, sd=0.290).

Increased vocalization rates during No Response suggest that the agents' contingency on vocal behavior led infants to expect their vocalizations to elicit responses. Differences in vocal directedness in No Response may suggest vocal probing strategies in uncertain situations. The higher proportion of agent-directed vocalizations in CC may have been motivated by the car's novelty to infants in comparison to CH. The higher proportion of caregiver-directed vocalizations in YC compared to CC may have been motivated by social referencing due to less certainty about the car's responsiveness. Thus, the contingency of agents, about which infants had little prior knowledge, built expectations for social interactivity.

P3-D-500 - Tone templates in Singapore Mandarin: An observational and experimental study

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Details

This is a study of early phonological development and word learning in children learning Mandarin Chinese in Singapore. Children's first words have been observed to be surprisingly accurate. As children produce more words, accuracy decreases: their productions begin to sound less like the targets and more like one another. The child's favoured word shapes or patterns may be referred to as 'phonological templates'; these are idiosyncratic child responses to the challenges presented by target word forms (Vihman & Croft, 2007; Vihman, 2019). As children learn increasing numbers of words, their templates reflect evolving self-(re)organisation and 'summarise' the child's emergent phonological repertoire. Two types of templates may be identified: children *select* words to produce that fit their preferred production pattern (and the target), but they *adapt* some words that are less like the pattern. Templates have generally been identified in segmental terms (consonants and vowels). However, tone templates have been reported for children learning Cantonese (Mok & Lee, 2018: 2-year-olds) and Mandarin (Lou, 2020: 13- to 18-month-olds). This study was designed to identify possible tone templates in the word forms of children learning Mandarin in Singapore (20- to 26-month-olds: spanning the end of the single-word period and the onset of combinatorial speech).

Two research methodologies were employed: a *longitudinal, naturalistic observational study* (audio- and video-recording, six monthly half-hour sessions in the home, *N* = 4) and an *experimental study* of the short-term retrieval and production involved in nonword repetition (responses to novel Mandarin stimuli: 36 disyllabic nonwords that conformed to Mandarin word patterns and took into consideration the frequencies of individual segmental sequence and tone sequence combinations as they occur in the language, *N* = 20).

Results from the two production tasks converged, revealing children's use of two T1-*x* tone templates: T1-1 and T1-0. In the naturalistic observations, T1-1 was both selected (as evidenced by greater use of words featuring this sequence) and used to replace more complex or less familiar tone sequences (i.e., some words were 'adapted' to the T1-1 sequence). In the experimental task, there were no T1-0 targets, but many nonwords were adapted to the T1-0 tone sequence: T1-0 was seemingly used as the de facto substitution tone sequence for less familiar tone sequences.

The use of the T1-x tone templates was expected, given that T1 is the most salient and most often produced (or 'practiced') Mandarin tone, in both babbling and early words (Lou et al., 2018). T1-0 has a falling contour that requires little effort to produce; this could account for the sequence also being deployed as a preferred pattern or template (cf. Kent & Bauer, 1985; Lou et al., 2018, Mok & Lee, 2018) for both words and nonwords.

These findings are in line with previous work suggesting that templates are not only relevant for learning segmental features, but also a provide a path for learning languages that contrast tonal features.

P3-D-501 - Unplugging potential: The impact of smartphone technoference on early language learning in parent-child interactions

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Details

Parent-child interactions play an important role in language development in young children. Parent technoference, i.e., disruption of a parent-child interaction due to technology, has been associated with a negative impact on child language outcomes.

The present study focuses solely on the mobile phone as the source of technoference and sought to test whether the way in which a smartphone is used during a period of technoference, moderates the impact of technoference on the learning of novel words. The study used both experiments and surveys, to allow for convergence across methods, to assess whether experiences at home are related to technoference and word learning. As smartphones become further integrated into our everyday lives, and parenting, it is important to understand the complexity of this relationship.

During a parent-child interaction, caregivers (N=69) taught their 2-year-old three novel words, one at a time, each for 60 seconds. In a within-participants design, we tested the child's learning of the words under three experimental conditions: (1) interruption from a phone call, (2) interruption by playing a

shared game on a phone and (3) no interruption. Whether the children had learnt the words was measured via looking time in an intermodal preferential looking paradigm. Caregivers completed surveys which assessed general levels of parent technoference at home. Technoference was measured using the DISRUPT (Distraction In Social Relations and Use of Parent Technology) (McDaniel, 2021), and by asking participants how frequently they put their smartphone away when with their child.

Preliminary findings (N=60) report no difference in how well the children learnt the words across the three conditions. There were also no differences in how often the caregiver repeated each word during the teaching across conditions, or in the children's level of engagement in the teaching before and after the smartphone interruptions. The level of parent technoference in the home as measured by the DISRUPT or how often parents put their smartphone away, was not associated with how well the children learnt the words, or the child's level of engagement during the teaching.

Whilst the findings appear to suggest that technoference does not affect the learning of novel words, I will discuss these findings and the implications of parental phone use on child development in the context of the existent and emerging literature in the field.

P3-D-502 - Infant statistical learning: the role of daily routines and maternal working hours

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Details

Both statistical learning (SL; Saffran et al., 1996) and routines in infants' daily experience (Snow & Beals, 2006; Ferretti & Bub, 2017) impact their vocabulary development. While SL is seen as an essential cognitive skill for pattern recognition and language development, it is unclear how it relates to infants' exposure to daily routines, which typically involve behavioral patterns that repeat over space and time. Infants' socioeconomic background, such as maternal working hours, might also affect their engagement with daily routines (McLoyd et al., 2008), potentially influencing vocabulary development.

Method: One hundred and eight 24-month-olds (range = 24.02-27.07 months, females = 57) participated in a lab-based SL task. Infants first listened to an artificial language where word categories were reliably distinguished by statistical cues that denoted word-referent pairings between two categories (animals and vehicles). They were then assessed on between-category and within-category novel word learning trials. (from Lany & Saffran, 2010). Infants' routine-related comprehensive vocabulary size was calculated based on the number of items checked in the *routine-related* subcategory in the MacArthur Communicative Development Inventory. This included five commonly cited child activities in the literature: bath, breakfast, dinner, lunch, and nap.

Results: No significant correlations were found between infants' routine-related receptive vocabulary size and demographic variables or between SL accuracy and demographic variables. For the main question of the study, a linear regression controlling for sociodemographic factors, such as maternal education and income, revealed that an increase in infants' routine-related receptive vocabulary predicts a decrease in

SL learning accuracy on the between-category novel-word-learning trials (B = -1.96, SE = 0.79, p = 0.01, 95% CI [-0.32,-0.076]). Given prior findings on the impact of maternal working hours on child routines, we performed a mean split (lower: <15.77 hours/week; higher: >15.77 hours/week). The association between routine-related vocabulary size and between-category SL accuracy was only significant for the lower working hours group (B=-0.27, SE=0.08, p=0.002, 95% CI [-0.44,-0.09]), but not for the higher working hours group (B =-0.14, SE=0.08, p=0.11, 95% CI [-0.32, 0.04]).

Discussion: Perhaps surprisingly, infants with larger routine-related vocabulary showed lower SL accuracy. Although infants' routine-related vocabulary size and SL ability were independent of maternal education or income, maternal working hours significantly affected the association between routine-related vocabulary size and learning accuracy, particularly for mothers working fewer than 15.77 hours. Mothers working less may engage more in routine interactions, influencing vocabulary growth through repetition. Conversely, those working longer hours might expose children to diverse linguistic experiences with other caregivers or in daycare, benefiting infants' novel-word-learning ability. Routines, while offering consistency and structure, have the potential to preclude exposure to diverse experiences, which is essential for acquiring new vocabulary. This can potentially impede language acquisition. For children growing up in predictable environments, there may be challenges in adapting to unpredictability (Cabeza de Baca et al., 2016). This raises important considerations regarding the balance between routine and variability in supporting language development.

P3-D-503 - Infant's comprehension of speech produced by children

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Details

Infants' language development is inherently tied to their linguistic experiences, but the majority of research on this topic has focused on what infants hear from adult caregivers (e.g. Hart & Risley, 1995) and how infants understand words produced by adults (e.g. Bergelson & Swingley, 2012). However, children do not exclusively interact with adults. In the US, 80% of children live in a household with other children (Current Population Survey, 2010), and research suggests that young siblings have slower language development (e.g. Havron et al., 2019). While this has been thought to be due to limits on parental resources (e.g. Blake 1981), speech from children differs from speech from adults and may be more challenging to understand. Here we ask how infants understand speech from young children.

Participants are 29 9-15 month old English monolingually-raised infants; 12 have older siblings (data collection ongoing). Participants completed an eyetracking-based word comprehension task. Infants saw two pictures on the screen (e.g. a baby and a spoon), and heard a sentence directing them to look at one (e.g. "Look at the spoon!"). Half of trials (n=16) were produced by adults, half (n=16) were produced by a 5-year-old.

We measured proportion of target looking during our analysis window, 367-4000ms post target word onset (based on Peekbank; Zettersten et al., 2021). If child-produced speech is more effortful to process, we would expect to see lower overall accuracy for infants processing speech from a child relative to an adult, and/or different looking patterns over time. We modeled looking to the target based on Speaker (adult or child) and four orthogonal time terms (Mirman, 2014). The best fit model included each time term, a main effect of Speaker ($t = -3.95$, $p < .001$), and interactions between Speaker and each of the time terms ($\chi2 = 31.98$, $p < .001$). Participants looked less at the target image when its label was produced by a child relative to an adult. The significant interactions between Speaker and each time term suggest different looking patterns by speaker over time (Figure 1).

Adding participant Age (younger: 9-11 months; older: 12-14 months) and Sibling Status (yes/no) to the model further improved model fit ($\chi2 = 854.06$, $p < .001$). Significant interactions between Speaker, Age, and Sibling Status ($t = 2.83$, $p = .004$) suggest that older infants looked to the target more than younger infants, infants with older siblings looked at the target more earlier, and older infants with older siblings performed best in the child speaker condition.

Taken together, results suggest that processing speech from 5yo children is more challenging for infants than processing speech from adults. Preliminary analyses suggest this challenge is attenuated for older infants who themselves have older siblings, suggesting a role for experience in learning to process this less canonical speech. Infants with older siblings may have to contend with processing more challenging speech in their input. Future research will investigate how this in turn influences their language development.

P3-D-504 - Derivational morphemes: Production in Mexican infants aged 30 to 48 months through joint reading sessions

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Details

Abstract

This study investigates the acquisition of derivational morphemes in monolingual Mexican Spanish-speaking infants aged 30 to 48 months and its relation with their parents' morphological production. Based on a comprehensive dataset of 120 dyads (30 dyads per age group) caregiver-infant engaged in joint reading sessions at the Infant Laboratory (Infant Laboratory, 2023; Bus, 2002; Valdés, 2015). Our goal is to find evidence of the presence of derivational morphemes inherent to Mexican Spanish and how infants develop this particular linguistic feature.

We conducted a quantitative analysis using types and tokens as measures to discern the frequency of derivational morphological production during joint reading sessions (Booij, 2006; Bus, 2002). The extensive corpus not only strengthens empirical evidence but also allows for a detailed exploration of Mexican Spanish morphology.

Results project an age-related increase in both types and tokens of morphological production (Smith & Johnson, 2020). There is also a strong relation between parents' morphological production and infant development, suggesting that input and context plays a key role in morphological acquisition. Cross-linguistic studies in Greek (Stephanye, 2021) and French (Kilani-Schoch & Xanthos, 2021) with infants aged between 1;6 and 3;0 showed similar results however, the same cross linguistic evidence strengthens the position of difference in early morphological acquisition between languages due to their own morphological behaviors.

A distinctive aspect of our methodology is the deliberate integration of joint reading sessions at the Infant Laboratory. Joint reading provides insights into linguistic inputs, cognitive processes, and morphological production within the specific linguistic context of Mexican Spanish (Mariscal & Benavides, 2017). Our focus on joint reading not only captures natural linguistic interactions but also enhances the ecological validity of our findings at the Infant Laboratory.

P3-D-505 - A longitudinal cross-cultural investigation of effects of maternal infant directed speech on infant language development in UK and Uganda

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Details

Infant-directed speech (IDS) is a special speech register which is typically slower-paced, higher-pitched, higher in emotional affect, with a greater pitch range and larger vowel space than adult-directed speech (ADS) (Saint-Georges et al., 2013). Such acoustic differences draw infants' attention to the speech (Senju & Csibra, 2008), potentially facilitating infant spoken language learning (Kuhl, 2004). In particular, vowel

hyperarticulation has been found to positively predict language outcomes (Dilley et al., 2020; Hartman et al., 2017). However, longitudinal evidence investigating how the acoustic qualities of IDS affect infant language development remains sparse. In addition, most studies have been conducted in Western Educated Rich Industrialised and Democratic (WEIRD) populations (Nielsen et al., 2017) using small sample sizes (Masek et al., 2021).
Here, we address these issues by examining the relationship between acoustic features (mean pitch, pitch modulation, vowel hyperarticulation, speech rate) of maternal IDS and adult-directed speech (ADS), when infants were aged 3-10 months, and parental reports of infant receptive and productive vocabularies at 15-18 months. Participants were sampled from two societies: one in or around the cities of York and Durham, UK (N=130) and one in the rural Masindi District of Uganda (N=103). Participants in the two samples differed in maternal socialisation goals, number of languages spoken by caregivers to the infants, and household size (Holden et al., 2022). We obtained audio recordings of IDS and ADS from home visits, where we asked mothers to talk to their infants as they usually would and separately to an adult experimenter in the same language. Mothers also named three objects for their infant and the experimenter to elicit the corner vowels /a/, /i/ and /u/ in IDS and ADS. All UK mothers spoke English to their infants, and Ugandan mothers spoke either Alur, Lugbara or Swahili. We obtained acoustic measures of IDS and ADS spoken by the mothers from these recordings. Infant vocabularies were assessed at 15-18 months using the Oxford 100 word CDI in the UK and translations of the Kiswahili CDI interview (developed in coastal Kenya; Alcock et al., 2015) to Alur, Lugbara, and Ugandan Swahili (with permission from the CDI board). To address the literacy needs of our participants, UK mothers completed the CDI in written form and Ugandan mothers were presented with the items verbally by a local research assistant fluent in the relevant language.
Our preregistered analysis plan aims to use GLMMs to examine the extent to which variation in infant vocabulary size at 15-18 months can be explained by acoustic features of IDS, and whether any effects vary with society (Uganda/UK). The difference between IDS and ADS on the four acoustic measures (mean pitch, pitch modulation, speech rate, vowel space) will be entered into the models as interaction terms with society. We plan to run separate models to predict receptive and productive vocabularies.
We have completed data collection and our pre-registered analysis plan can be found here https://aspredicted.org/Q49_KT6
We will present the results of these statistical models and discuss their implications.

P3-D-506 - Is infant mouth-looking driven by IDS intonation or ID singing rhythm

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Details

Infant-directed speech (IDS) refers to a set of prosodic and facial modulations used by adults when addressing infants. IDS is a cross-cultural phenomenon and is usually marked by higher mean fundamental frequency as well as a higher pitch (f0) range, slower tempo and reduced rhythmic variability (Alviar et al., 2023; Grieser & Kuhl, 1988). IDS has reliably been shown to be more effective at attracting infants' attention to the speaking mouth than adult-directed speech (ADS) (ManyBabiesConsortium, 2020; Alviar et al., 2023; Lewkowicz & Hansen-Tift, 2012). This has led to the suggestion that IDS promotes language learning in infants by making the speech stream slower and

easier to segment, as well as providing audio-visual redundancy to attract infants' attention (Nencheva & Lew-Williams, 2022). In a study by Lewkowicz & Hansen-Tift (2012) using an eye-tracker, infants were shown videos of a woman speaking in either their native or non-native language. While infants from 6 to 8 months were shown to look at the mouth for both stimuli, mouth-looking decreased at 12 months for native stimuli while remaining prevalent for non-native stimuli. This suggests a relationship between mouth-looking and language disambiguation and learning. In our study, we investigate which of the prosodic features in IDS are responsible for the promotion of mouth-looking, as well as of language learning. For this purpose, we contrasted IDS with infant-directed singing: an alternative which has also been found to promote mouth-looking while having different prosodic characteristics (Alviar et al., 2023). We created 1-minute-long video stimuli of a woman reciting two stories in either ASD, IDS or ID singing. These 6 videos were shown to French infants aged 3, 6, 9 and 12 months (n = 183) using an eye-tracker. Firstly, we expected the general tendency to mouth-look to follow the 6 month-old mouth-shift observed by Lewkowicz & Hansen-Tift (2012). Our data seems to reflect the usual increase in mouth-looking at 6 months (see fig.1). Secondly, based on previous research on American infants (Alviar et al., 2023), we expected that a comparison between the IDS and song videos would show the rhythmic regularity of ID singing driving looks to the mouth more effectively than the wider pitch (f0) range of IDS. Our results failed to show a significant relationship between song/IDS conditions and overall mouth-looking, suggesting that the prosodic differences in the stimuli did not have an effect on mouth-looking. However, an interaction effect (p = .04) with the story was found, with one story driving mouth-looking in the IDS condition, and the other story in the song condition (see fig.2). We will discuss our interpretation of these results, along with potential follow-up granger test analyses where mouth-looking is explored only at the locus of rhythmical beats (Lense et al., 2022).

P3-D-507 - Speech perception under noisy conditions in monolingual and bilingual infants

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Details

Listening to someone speak is a complex task even under the best circumstances. Ideal listening conditions are rare, and individuals often listen to speech in noisy environments. The speech signal is often imperfect, and a noisy background may mask this already suboptimal signal (Lecumberri et al., 2010). Fortunately, compensatory strategies exist.

One way in which listeners can disambiguate noisy speech is by relying on pre-existing language knowledge. For example, adults typically understand speech in noisy conditions better if they can rely on semantic (Golestani et al., 2009) or lexical context (Kaandorp et al., 2016). However, reliance on language-based knowledge to decipher an imperfect signal is only one among a set of cognitive and perceptual skills. For instance, background noise seems to differentially impact adults and younger children. Namely, a 'developmental listening disadvantage' has been demonstrated in children under 15 years and is thought to be linked to cognitive and perceptual abilities that are not fully developed in younger listeners, in addition to language proficiency when two or more languages are involved (Johnson, 2000; Nelson et al., 2005; Neuman & Hochberg 1983).

Developmental research on infants' language-related perceptual and lexical development rarely examines the impact of background noise on speech perception, and when it does, only monolingual individuals with homogeneous language exposure experience are tested (e.g., Leibold et al., 2016; Newman, 2005, 2009). The underlying cognitive processes and language exposure experiences involved in speech perception could differ significantly between monolinguals and bilinguals in this most rapid language acquisition phase of the lifespan. Indeed, for infants learning in a complex language environment, underlying mechanisms of language perception may differ than those of monolingual infants (e.g., Werker et al., 2009). This may imply that the larger cognitive load associated with the process of perceiving words in noise may negatively impact bilinguals' performance compared to monolinguals. Further, they may have weaker word recognition in the target language due to reduced exposure (Morini & Newman, 2020).

In this study, we investigated how infants with various language environment exposures, aged 12 to 14 months, deal with listening to and recognizing familiar words when hearing other people talking on top of the other, as it often happens at home, at day care, etc. We assessed recognition accuracy in a group of English monolinguals and French-English bilinguals on a preferential looking task consisting in hearing targets (i.e., English labels) for familiar objects in an auditory environment that included different levels of overlapping babble (i.e., 2- and 9-talker babble). We also assessed the participants' English proficiency and English exposure with parent-reported measures. We so far have tested 15 infants toward our targeted sample size of 34. Using mixed ANOVA and correlational analyses, we will compare task performance with levels of noise and language exposure. We expect poorer performance from the bilingual group. Indeed, larger cognitive load associated with the process of perceiving words in informational noise and a weaker language knowledge may negatively impact them compared to monolinguals (e.g., Newman, 2009; Polka et al., 2008; Werker et al., 2009).

P3-D-508 - The impact of speaker race and language experience on infants' language expectations

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Details

Globally, multilingualism is more common than monolingualism and communities are increasing in diversity in line with increased immigration (Tucker, 199; OECD, 2021; Statistics Canada, 2022). This means that infants are learning language in a far more socially (e.g., race) and linguistically diverse environment than ever before. While it was previously thought that the race of speakers was ignored by infants during language acquisition, recently, models of speech perception have begun to include and account for socio-indexical information (e.g., race, gender, age) (e.g., Foulkes & Docherty, 2006; Weatherhead & White 2018). Examining the developmental trajectory of when and how social information begins to play a role in language perception is an important task for developing more generalizable models of language acquisition that reflect the diversity of real-world environments.

The current study explores how non-linguistic social properties influence the assumptions infants make about speakers. We explore whether speaker race affects whether infants expect an unfamiliar individual to be monolingual or multilingual. Previous research has found that at 20 month old

monolingual infants expect others to speak only one language while bilingual infants do not demonstrate the same expectation (Pitts, et al., 2015). Our study extends this question by exploring how many languages infants expect people to speak while accounting for the effect of speaker race.

In this study, *N*=28 (recruitment ongoing) Canadian and American infants aged 15 to 24 months old (*M*=18*)* participated in an asynchronous, virtual experiment. Participants were randomly assigned to one of two conditions: they were shown either a speaker of a familiar or unfamiliar race. Participants were familiarized to the speaker speaking English then viewed 12 test trials which randomly alternated between the speaker speaking English (language consistent trials) versus Spanish (language inconsistent trials). Participants looking behaviour towards the screen was measured for each trial, with greater looking times indicating expectation violation. Based on a conventions view of language (Clark, 1996) we expect that infants will look longer when a speaker of a familiar race to them speaks a different number of languages than them and that they will not hold strong expectations for speakers of an unfamiliar race.

Preliminary results suggest a complex relationship between infant's language experience, race familiarity and age in guiding infants' language expectations. First, consistent with Pitts et al., 2015, it is possible that monolinguals but not bilinguals expect others to also be monolingual earlier in infancy (15-20 months) but not in later infancy (21-24 months). Next, monolingual but not bilingual infants appear to be looking longer at the inconsistent trials when viewing a familiar race speaker compared to an unfamiliar race speaker and this effect appears to increase with age. Consistent with our hypothesis, this suggests that infants have expectations of other's language based on their race, and that they expect those of a race similar to them to have the same language experiences as them.

These findings will aid psychologists, linguists, educators, speech-language practitioners, and policy makers, as children encounter speakers of diverse racial, cultural, and linguistic backgrounds.

P3-D-509 - Multilingual infants in Ghana's ability to use tongue root harmony cues for word segmentation in Akan

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Details

Many infants worldwide are exposed to multiple languages, and multilingual experience can affect infants' ambient language(s) processing. Exposure to multiple languages is the norm for infants growing up in Ghana, as in most other African countries. Many African languages, e.g., Akan, have vowel harmony, a phonotactic constraint that requires vowels within words to be similar. Monolingual infants learning VH (Van Kampen et al., 2008) and those learning non-VH (Mintz et al., 2019) languages use VH cues for word segmentation. This raises the question of whether infants learning multiple languages with and without VH would use VH cues for segmentation, and whether this depends on the relative amount of exposure to VH languages. In the present study, we focused on ATR harmony, a vowel harmony type common in African languages (see Casali, 2008; Rose, 2018). We hypothesized that multilingually raised infants

exposed to minimally one ATR harmony language will use ATR harmony cues for segmentation and that exposure to an ATR harmony language might modulate this use.

Forty 9-11-month-old multilingual infants in Ghana (an understudied population), learning between two and five languages, with minimally one showing ATR harmony, were tested. Their segmentation was measured in an experiment using the central fixation procedure, in our mobile lab in Accra. Infants were first familiarized with text passages embedded with target bisyllabic words (e.g., dibu) that either disharmonized with an attached CV suffix (dibu-kɛ: providing a word boundary cue) or harmonized with the attached CV suffix (dibu-ke: providing no cue). Infants were then tested on their recognition of the familiarized target words and novel words. Infants' language exposure was assessed with a questionnaire and a diary logbook.

Results revealed a familiarity preference: infants' LTs to familiarized words in disharmonic context was longer than those in the harmonic context (p = .05) and novel words (p < .05). These results suggest 9-11 months old multilingual infants learning ATR harmony language(s) alongside non-VH languages use ATR cues to identify word boundaries. No effect of language exposure was found (p = .47), suggesting that minimal exposure to (an) ATR harmony language(s) could be enough for young multilingual infants to use ATR cues in language processing. This study provides the first evidence of segmentation with ATR cues and in infants learning both VH and non-VH languages simultaneously. Our findings suggest that multilingual infants are aware of the distinct phonotactic inputs and rely on language-specific cues during processing.

P3-D-510 - Late talker status and family media practices are associated with screen time during infancy

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Details

Late talkers (~20% of toddlers) are defined as scoring below the 10th percentile on vocabulary measures (e.g., Henrichs et al., 2011). Late talkers process language in different ways than typically developing children, with different attentional patterns (Ellis et al., 2015), slower processing speed (Fernald & Marchman, 2012), and poorer mapping ability (Kucker & Seidler, 2023). Prior research has demonstrated that high levels of media exposure (Sundqvist et al., 2021), and absence of parent-child co-viewing of media are associated with poorer language outcomes (Celenn Yoldas et al., 2021), perhaps by displacing parent-child verbal interaction (Kirkorian et al., 2019). The present study extends prior work by examining relationships between late talker status and family media practices. We conducted two cross-sectional analyses: first, to examine whether late talker status was associated with screen use when accounting for demographic factors and other family media use practices; and second, to examine whether family media practices were associated with vocabulary development.

Methods. Parents of children (47% girls) 3 years and under (M = 23 months, SD = 6.4), completed the CAFE Toolkit that measures coviewing practices and reasons for media use and the MacArthur Bates

Communication Development Inventory Short-form level 1 or 2 (Fenson et al., 2000). Participants were drawn from studies conducted across the US, including 535 collected before the pandemic (2018-2019) and another 476 collected after 2020 (2021-2023). In our sample, 24% were late talkers (10th percentile or less on MCDI).

We predicted children's weekly TV viewing from demographic factors (child age in months, parent ethnic minority, parent race minority, 4-point parent income and education index, English as the primary language in the home), family media use practices (coviewing frequency, using media to calm, educate, or keep busy), time period (pre-2020/ post-2020), and late talker status. See Table 1. We found that late talker status was associated with 108 more minutes of screen time use per week on average, when controlling for all other variables in the model. We also found that levels of screen time were, on average, 254 minutes higher per week (keeping all other variables constant) after 2020 (versus pre-COVID), which is consistent with several other recent findings showing an increase in screen time during the pandemic.

We also modeled the vocabulary percentile using the same predictors (replacing late-talker status with weekly TV viewing) and found that using media to calm the child was associated with a 7 percentile decrease in vocabulary score, whereas using media to educate was associated with a 5-point increase (keeping all other variables constant). Other media use practices, including total TV viewing, were not associated with vocabulary percentile.

Overall, these findings show that family media practices are important considerations in predicting media use and language outcomes, and the reasons parents use media with young children may be more important than the total amount of media use. Future longitudinal analyses will examine whether late talkers are at differential risk of media use effects.

P3-D-511 - Development of the ability to use acoustic cues for auditory selective attention

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Details

Understanding speech in the presence of noise is likely related to auditory selective attention, or the ability to direct one's attention to a particular sound source. For adults, comprehension of speech in noise is much better when the noise differs from the speech in an obvious manner. Thus, adults are better at listening to speech when a noise source comes from a different location in space (e.g., Broadbent, 1954) or when a background talker differs in sex from the target (Brungart et al., 2001).

But recent work has suggested that this is not the case for infants. Leibold, Buss and Calandruccio (2019) found no advantage for a sex-difference between target and background talkers in infants aged 7 or 13 months, and Newman & Morini (2017) likewise found no difference in 16-month-olds. The two studies used different populations, different methods, and different stimuli, suggesting that this failure to find a

difference is not a result of something specific to the methodology – rather, infants truly seem to ignore what appears to be a rather obvious acoustic cue distinguishing sound sources.

The current study examined whether infants might likewise ignore other, apparently obvious, cues to stream segregation and selective attention. We examined whether infants showed better speech comprehension when a noise source differed from the target either in spatial location or spectral frequency range compared to when it overlapped (same ear, same frequency range). We found that while adult listeners showed much stronger comprehension performance when the noise differed from the target by either cue (both $p<.0001$), infants appeared to be equivalently distracted by non-overlapping as by overlapping noise, suggesting they fail to use these acoustic cues for selective attention. (As one example, 16-month-olds looked to the correct object both with spectrally-overlapping noise (55%, $p<.02$) and nonoverlapping noise (57%, $p<.02$), a non-significant difference ($t(24)=-1.02$, $p>.3$.). We will discuss what these results imply about development and attentional skills.

P3-D-512 - Effects of financial concern on infants' real-time home language experiences

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Details

In recent years, there has been considerable focus on documenting differences in the home language environment that children from families of high SES vs. those from low-SES experience (e.g., Fernald et al., 2013; Hart & Risley, 1995; Rowe, 2008). However, many studies neglect the fact that there is substantial variability in the input provided by individual parents within low-SES communities, emphasizing that parents' behavior is shaped by factors beyond SES alone (e.g., Hoff-Ginsberg, 1998; Hurtado et al., 2008; Weisleder & Fernald, 2013; Schwab et al., 2018). Also, it is widely acknowledged that low-SES households may provide different experiences (e.g., Shonkoff et al., 2012). We investigate how real-life challenges faced by parents in poverty – in particular, the cognitive demands of having to worry about insufficient financial resources – can affect interactions with their children and impede the language input they would otherwise be able to provide.

Families of 18-30-month-old infants participate in two sessions (self-reported high and low scarcity time), approximately 2 weeks apart. On each of the two days, audio recorders were collected with the Language Environment Analysis™ system (LENA), which provides counts of parent language (quantity) input and number of turns taken (quality) between parent and child across a full waking day. Additionally, parents receive 6 text message surveys: 3 Financial and 3 Control texts, across the day in a randomized order (based on previous piolet survey data from 240 low-income parents). We measure parents' language input on mutliple time scales (5- and 2-minutes) pre and post survey and over the course of the day, to investigate whether speech is affected by the need to consider financial challenges. We hypothesize that prominent financial concerns capture the attention of parents and, in turn, affect their interactions with their children and the quality and quantity of language input they are able to provide.

While, data collection is ongoing, our pilot study with 22 low-income families showed that when parents were asked to respond to hypothetical scenarios that involved financial challenges, they spoke less to their toddlers in the minutes that followed, while parents asked to reason about non-financial challenges showed no such change (Figure 1). The current study extends these findings to real family life, to understand how financial concerns faced by low-income families affect parents' everyday communication behaviors in their own homes. Using fine-grained measures of children's language input and vocabulary levels in tandem with nuanced measures of work and home life, we gain new insights into the real-life circumstances that contribute to important differences in the experiences of low-SES young children.

P3-D-514 - Investigating prenatal speech processing in foetuses with and without increased likelihood of developing autism: A preliminary analysis.

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Details

When talking to babies, adults often use infant-directed speech (IDS) characterised by altered linguistic patterns and exaggerated prosody. Neonates can discriminate differences in prosodic patterns between IDS and adult-directed speech (ADS) and prefer listening to IDS over ADS and B-IDS, suggesting that biases for IDS may be genetic in origin. Furthermore, infants with increased likelihood of developing autism (i.e. those with an autistic older sibling or parent), a neurodevelopmental condition with high heritability, show reduced and delayed preference for IDS, potentially indicating genetic differences in speech perception. However, important differences in prenatal environments are underappreciated in genetic accounts. Although 89% of women speak to their foetus in IDS, those scoring high on depression scales talk and sing less, suggesting that mothers' emotional states might affect how many hours their foetus is exposed to speech. As caregivers of autistic children are more likely to experience mental health problems than the general population, their foetus' prenatal environment and exposure to language may differ, potentially offering a non-genetic explanation for their reduced sensitivity to IDS.

Our objective is to investigate the potential roles of genetic and the prenatal environmental influences on the development of infant preferences for IDS. We will assess sensitivity to IDS, compared to ADS, in foetuses with- and without- increased biological likelihood of developing autism. We will also measure both negative and positive emotional experiences of mothers with questionnaires. IDS, backwards IDS (B-IDS), and ADS sounds recorded by a female researcher will be presented to the foetus between 32 and 34 weeks' gestation (N = 110). We will measure foetal heart rate as an indicator of arousal and use ultrasound to measure foetal behavioural responses across speech conditions. We predict that, overall, foetuses will show arousal, indexed by faster heart rate, in response to IDS and ADS compared to B-IDS. These results would potentially indicate that, even in the womb, a foetus can discriminate the linguistic and prosodic components of speech and attend to prosodic characteristic of speech more. However, foetuses with increased likelihood of developing autism and whose mothers experience negative emotions during pregnancy will show less attendance to speech overall and there will be smaller differences between their sensitivity to IDS compared with other speech conditions. The results of the

study will indicate the importance of environmental and genetic effects on speech perception and will provide new insight into the aetiology of autism. Additionally, understanding the early mechanisms of autism and possible environmental factors influencing speech perception is crucial to supporting the mental wellbeing of the mothers. Currently we have 11 data from infant without family history with autism.

P3-E-517 - Examining joint attention in signed interactions: The influence of sign familiarity

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Details

Children's ability to engage in Joint Attention (JA) has been shown to support word learning and subsequent vocabulary development (Abney et al., 2020; Morales et al., 2000; Yu et al., 2019). While most JA research primarily focuses on spoken interactions, previous studies have shown that deaf children acquiring a sign language display a higher sensitivity to gaze cues, increased gaze-switches and more mutual gaze in interactions relative to hearing children learning a spoken language (Lieberman et al., 2014). However, it is unclear what role JA plays in the acquisition of new signs and how the structure and timing of JA might differ depending on sign familiarity. To answer this question, we examined properties of JA sur-rounding naming events (NE) in signing dyads, comparing the impact of sign familiarity onto different JA characteristics and on children's vocabulary. We aim to enhance our comprehension of JA in signing dyads by examining properties of JA surrounding NE and its impact on children's vocabulary. Comparing familiar and novel NE, we aim to increase our under-standing of the role of JA in word learning. We predict caregivers will display sensitivity to a signs' familiarity and modulate JA correspondingly.
Method. We analyzed the ASL-PLAY dataset (https://osf.io/3w8ka/) of 12-15-minute-long video-recordings of caregiver-child interactions in ASL. Deaf children aged 9 to 69 months were interacting with a caregiver in either "familiar" (n =23, x̄= 35m.o.) or "novel" play sessions (n = 31, x̄ =41m.o.). Novel sessions included both familiar and four novel objects, each associated with a novel sign borrowed from other sign languages caregivers were taught before the session.
Coding. We focused on JA around "naming events", defined as instances in which a concrete object (familiar or novel) was labelled by either the caregiver or child. We analyzed gaze, touch, attentional behaviours and ASL signs surrounding all NE, and identified JA episodes based on the coding scheme for JA developed by Gabouer and Bortfeld (2021). Based on these annotations, we identified the success of each JA initiation attempt, the duration and frequency and behaviours involved in the JA episode, and the timing of the NE within the JA episode.
Results. Across 587 familiar and 493 novel NE, frequency and duration of JA episodes showed no significant differences based on sign familiarity. However, we found significant differences in the way caregivers structure and time JA events surrounding relevant NE. Naming familiar objects often incorporated the object label into JA initiation, whereas naming novel objects rarely did (Figure 1). Caregivers seemingly prioritize establishing JA before naming a novel object, strategically timing NE within JA episodes to enhance the child's successful sign-object mapping. Further, this effect was found to be strongest in those instances in which a novel sign occurred for the first time within the novel set, further supporting the assumption that caregivers modulate JA around novel NE.
Our results show that caregivers interacting with deaf children in ASL are sensitive to the child's prior knowledge of object labels, and shape their interactions to support their child's language acquisition.

P3-E-518 - Bilingual infants' discrimination of speakers

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Details

The ability to recognize voices is paramount in language development. Voice recognition occurs by discriminating auditory and visual information provided by the speaker. Speakers produce unique sounds due to variations in the physiognomy of the mouth, nasal passage, jaw muscles, vocal cord length and tension, and muscles used to articulate (Kulshreshtha & Ramkumar, 2012). Personal differences create unique voice characteristics and affect the sounds produced in speech, which help listeners recognize a speaker as uniquely different from others. Discerning voices is an important process, beginning prenatally and developing in the first stages of language acquisition. Infants recognize maternal voices perinatally (Kisilevsky et al., 2003) and specific maternal phoneme productions affect infant phonetic perception (Cristia, 2011). Beyond identifying voices, tracking number of voices is also important, as discriminating 'one' from 'more than one' supports language development in perceiving the number of speakers (i.e., one or more speakers). This is important in language detection and social development, as infants must recognize the origin of sounds as threat, ally, or noise, along with its message. Little is known about an infant's discrimination between numbers of voices. All the above is more complex in a bilingual environment, where within-speaker language changes could complicate infants' voice tracking. Our eventual project goal is to test bilingual infants on their recognition of a within-speaker language change being the same voice. However, we first need to test whether bilingual infants can recognize a speaker number change and a language change. The former is unknown, but the latter is expected based on past research (e.g., Bosch & Sebastian-Gallesm, 2001).

We are adapting the procedure of Johnson et al. (2011) where they found monolinguals of 7 months could detect voice changes in native, but not non-native, languages. as a guide. Our goal is to test 18 bilingual infants of 7 months. We currently have tested just under half of that sample (n = 7) and have preemptively begun to test infants of 11 months (n = 3) in case the younger infants do not succeed. In each trial, infants habituate to three speakers speaking in a native language: either English or French (counter balanced across subjects). At test, looking time is determined for familiar trials (e.g., A-English, B-English C-English), novel voice trials (e.g., A-English, B-English, D-English), and novel language trials (e.g., A-English, B-English, E-French). An infant should typically visual attention to stimuli considered new and interesting; thus, looking time provided an overt behavioural proxy for perceptual discrimination.

Our analysis plan to compare the three test trial types using a within-subjects ANOVA, with alpha-controlled post-hoc comparisons of familiar versus novel voice and familiar versus novel language. If the 11-month group is added, we will adapt the analysis to a mixed 3 (test) by 2 (age) ANOVA. Data collection for this study is ongong, and results will further our understanding of bilingual infants ability to detect number of voices and track speaker identity in complex language environments.

P3-E-519 - Test-retest reliability of rule learning measures in infancy

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Details

Language development is thought to depend on infants' ability to learn and generalize abstract algebraic rules. The cornerstone work in infant learning and infant language development by Marcus (1999) has been replicated in many studies with a large heterogeneity in reported effect sizes. The ManyBabies3 consortium, an international consortium of infancy researchers, is currently conducting a large-scale, multi-site experimental test of this foundational ability in infants using three different looking time methods. A key question of theoretical interest is to understand not only infants' overarching ability to learn rules, but to understand how variation in individual infants' learning abilities leads to different developmental trajectories and outcomes. To study these individual differences, it is essential to know how stably a certain ability can be measured over multiple measurement time points. However, research on the reliability of infant looking time measures to date has been sparse and has found little or no evidence of test-retest reliability (Marimon & Höhle, 2022; Crista et al., 2016).

In this project we will focus on three questions. (1) What is the overall test-retest reliability of infant rule learning, as estimated by correlations in looking time preference between test sessions and linear mixed-effects modeling? (2) Is test-retest reliability moderated by a variety of participants (infant age; native language; multilingual exposure) and design characteristics (experimental method; time between test sessions)? (3) To what extent does reliability depend on requiring a larger number of test trials for inclusion (i.e., more precise measurement of individual infants' looking preferences)?

For this purpose, 13 labs from the ManyBabies3 consortium from various countries (Austria, Canada, Czech Republic, Germany, The Netherlands, Israel, Italy, Norway, UK, US) will contribute to this project by re-recruiting their participants for a second test session 5 to 9 days after the first session. Our planned sample size is at least 150 infants. During both sessions, first, infants are familiarized with the ABB or the ABA rule for 2 minutes by a repeated presentation of these patterns consisting of naturally spoken syllables. Each of 16 sequences is presented 3 times. In the following 12 trials of the test phase, infants listen to ABB and ABA patterns in random order while their looking times are assessed. The stimuli in the second test session used the same syllable sets from the first session, while varying the specific rule sequences.

At the ICIS we will present and discuss the results of the project. Additionally, we will discuss the implications of our findings for conducting longitudinal studies of infant language development and provide recommendations for improving the reliability of infant looking time methods.

Link to the pre-registration: https://osf.io/ma8z5

P3-E-520 - Tracking what others want to know: The early ontogeny of questions processing

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Details

We investigated infants' processing of questions, defined as interrogative sentences used to convey a request for information. Adults and preschoolers disambiguate questions by assuming that people request pieces of information that they lack (Aguirre et al., 2022). Thus, processing questions requires taking into account what speakers are ignorant about. We studied the early ontogenetic emergence of this ability and tested whether infants are sensitive to the information-seeking function of interrogative sentences, in four eye-tracking experiments (N = 248).

In Study 1, 30-month-olds viewed videos in which an actress placed two unfamiliar objects on a table, and left. While the actress was away, the objects were moved towards new locations. When the actress came back, she could see only one of the unfamiliar objects (the “visible object”), and not the other one (the “hidden” object). Next, the actress asked a question using an ambiguous unfamiliar label (“*Where is the tralet?*”). Importantly, the novel label’s ambiguity could be resolved by assuming that the speaker asked about the location of the object that she could not see.

During the forced-choice phase of the test condition, the two unfamiliar objects were shown side by side, and participants were encouraged to look at the “tralet”. We measured participants’ proportion of looks towards the hidden object out of their total looking towards both unfamiliar objects, 367-2000 ms post-label-onset (Swingley & Aslin, 2000). In all Studies, baseline conditions served to test whether participants’ gaze behaviors were specifically due to their processing of the unfamiliar label. In Study 1’s test condition, 30-month-olds’ average proportion of looks toward the hidden object was above chance level (Fig. 1, ST1).

Subsequent studies investigated the ontogeny of infants’ sensitivity to the information-seeking function of interrogative sentences. Study 2 was identical to Study 1, and tested 18- and 14-month-olds. In Study 2, participants succeeded at disambiguating the novel label at 18 but not at 14 months of age (Fig. 1, ST2). Study 3 showed the same pattern of results in a simplified paradigm (Fig. 1, ST3).

Study 4 tested whether 14-month-olds could nonetheless discriminate questions from declarative sentences. Study 4 was identical to Study 3, except that instead of asking a question, the actress used a declarative statement (saying “There is the tralet!” instead of “Where is the tralet?”). Thus, in Study 4, the ambiguity of the novel label could be resolved by assuming that it referred to the visible object. In Study 4, 14-month-old participants' average proportion of looks toward the visible object was higher than predicted by chance (Fig. 1, ST4), and higher than in Study 3.

Thus, humans’ sensitivity to the information-seeking function of interrogative sentences emerges during the second year of life. Fourteen-month-olds process interrogative and declarative sentences differently. They appropriately use information about what speakers can see when processing assertions, but not when processing questions. By 18 months of age, infants’ interpretation of questions is guided by the foundational assumption that people use interrogative sentences to request information that, for them, is new rather than already known.

P3-E-521 - Lexical organization in Spanish children with Down syndrome: thematic and taxonomic relations

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Details

Individual differences in the way children organize objects and the vocabulary related to them has recently began to be studied. Some indirect empirical evidence on this matter shows that infants are sensitive to both taxonomic and associative links at 24-months of age (Arias-Trejo & Plunkett, 2013) and that 18-month- old infants listen longer to taxonomically related lists of words than to unrelated lists, demonstrating a sensitivity to the semantic relationships between words at this young age (Delle Luche et al.,2014). However, the order in which associative and taxonomic representations emerge remains unclear (associative links develop first: Perraudin 2009; taxonomic relations precede associative ones: Markman & Hutchinson,1984; simultaneous development: Arias-Trejo & Plunkett, 2013). On the other hand, lexical organization has received little attention in children with Down Syndrome (DS).

From the second year of life, children with typical development (TD) exhibit the capacity to establish relationships between words. Nonetheless, this skill has not been extensively investigated in children with Down syndrome (DS).

One of the few studies (Barrón-Martínez, Arias-Trejo & Salvador-Cruz, 2022) investigated the ability in children with DS to establish associative relationships between words that tend to occur in the same context. The investigation showed an associative priming effect, their results suggest that people with DS possess a lexical organisation.

In this present work we compared the vocabularies and corresponding semantic networks: thematic and taxonomic relations for 9 Typical development infants (mean chronological= 1.9 years) and 9 children with Down syndrome (mean mental age = 3.5 years). Children's vocabularies were collected thru a widely used parent checklist, an adapted version for children with DS of MacArthur-Bates Communicative Development Inventory (Galeote et al 2006). Networks were constructed according the words in each child's vocabulary and also in agreement to the co-occurrence statistics of the words in a normative language-learning environment. Each child's semantic network was derived from the list of words that parents reported their child to use in everyday speech.

For each individual child's network, three network statistics (in-degree, clustering coefficient, and geodesic distance) were computed in an open-source software for graph and network analysis (GEPHI

0.9.1). Results showed that the DS lexical networks (M=0.19; SD=.04) have a higher average of clustering coefficient [t (1,16) = 2.37, p < .05] than the TD lexical networks (M = 0.13; SD = 0.066).

Thus DS networks showed more local structure than TD networks.

Furthermore, we found that children with DS networks were configurated with more thematic relations between words over taxonomic relations and also showed a preference for non-living concepts. This suggests a kind of advantage/benefit in children with DS. This appearing advantage allows them to extract contextual and functional properties of objects and configurated a lexicon with a particularly kind of organization. Also, differences between the two groups may be related to the differences in exposure to contextual relations, independently of children's mental age. Thus, experience may be playing an important role in providing detailed information, which reduces distance between words (Stella et al 2017).

P3-E-522 - Infants' understanding of the imperative function of communicative actions

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Details

Previous results (Tauzin & Gergely, 2018, 2019) show that young infants can recognize that the contingent exchange of variable as opposed to fully predictable non-speech signal sequences allow communicative information transfer. Moreover, they can infer that communicative sound sequences can transmit goal-relevant information to correct the false belief of an ignorant agent. However, it is unclear whether infants can also understand that communicative signals can be used to directly change others' behavior as opposed to change their epistemic mental states.

In the present empirical study, we aimed to reveal whether infants expect that Variable as opposed to Identical signal sequences can be used to change others' behavior (hypothesis 1); only Agents as opposed to inanimate Objects can react to such signals (hypothesis 2); and agents can only exhibit intentional behavioral reactions (Location-change) as opposed to impossible (Shape-change) actions (hypothesis 3). We showed animated videos to 12-13-month-olds in four experiments (*N*=20 each) and measured their cumulative looking time. In the four familiarization trials of each experiment a flatfish-like agent entered the scene and either pushed six inert object recipients or chased six self-propelled agent recipients (cubes or spheres respectively) to scattered locations behind an occluder. Then, the flatfish turned towards another, flatfish-like entity and exchanged variable signals with it or produced identical signal sequences without receiving any response. In the subsequent four test trials only the first flatfish entered the scene and it pushed or chased the six entities to the same location as before. When the entities were fully occluded the flatfish turned towards the occluder and produced sound sequences that involved either variable or identical signals. Subsequently, the occluder lowered and the six entities either appeared in an ordered arrangement (instead of the scattered array) or their location did not change but their shape was different. We varied signal type within-subjects and recipient and response type across subjects.

The results of the completed data collection show that infants' looking time was significantly longer– thus, indicating surprise– when the Location of the Agent recipients changed in the Identical as opposed to Variable signals condition; when the Shape of the Agent recipients changed in the Variable but not in the Identical signals condition; when the Object recipients exhibit either the Location- or Shape-change in the Variable as opposed to the Identical signals condition.

These findings indicate that infants can recognize that only variable, turn-taking signals can serve the communicative function to affect the overt behavior of others (hypothesis 1). Moreover, they can also comprehend that agents as opposed to inert objects can react to such communicative cues (hypothesis 2) and agents can only produce behavioral reactions that are intentional and presumably under voluntary control (hypothesis 3). Our findings are compatible with the view that infants–apart from understanding that communication can be used to achieve epistemic goals–have an early sensitivity to the imperative use of communicative signals.

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P3-E-523 - Two-year-Olds' communicative behaviors in video chat

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Details

Coronavirus (COVID-19) outbreak developed into a global pandemic in 2019. In order to avoid the spread of the virus, real-time video chat app quickly became a way for people to communicate during the epidemic. Under the impact of coronavirus, video chat has become popular. Not only are adults using video chat for remote work and meetings (Kshetri & Kshetri, 2020; Uohara et al., 2020; Wiederhold, 2020), children are also having more opportunities to learn or interact with family members far away remotely (McClure et al., 2018). It is thus important to understand the limitations of young children's ability to use video chat for learning and communication. In the present study, we investigated how 2-year-olds (N = 32) communicated, by way of pointing, gaze, and naming, with an experimenter on the computer screen whom they met for the first time about objects in their own or the experimenter's environment. We used Google Meet for video chat. As shown in Figure 1, there were four within-subjects conditions: a target object was in front of or behind the child and the experimenter, respectively. The experimenter pointed towards the object when it appeared in front of her or behind the child, and the child was given an opportunity to respond to her communication. By contrast, the adult was ignorant of the object when it appeared in front of the child or behind her, and this allowed the child to actively influence her attention. The results indicated that, when the object was in front of or behind the adult, the children not only spent more time watching the screen, F (3,28) = 64.16, p <

.001, but also were more likely to point toward the screen (see Figure 2), χ^2 (3, N = 32) =27.61, p < .001, and name the objects on the screen, χ^2 (3, N = 32) =34.134, p < .001, compared to when the object was in front of or behind the child. When the adult pointed toward the object behind the child, 14 children turn their heads at least once; 75% of the head-turning responses (18 of 24) were towards the target location, which was greater than chance, t (13) = 2.46, p = .015. When the object was in front of the child, 6 children exhibited showing gestures, which were not observed in other conditions. Virtually no request gestures were seen across conditions. The differential patterns of responding suggest that 2-year-old children adjusted their communicative behaviors according to the location of objects and adult's shared attention in the video. Results are discussed in relation to (1) the effects of misalignment of pointing gesture and saliency of the target object, (2) children's motivation and ability to engage in joint attentional interaction with people on the screen, and (3) implications for social cognitive development.

P3-E-524 - Infant temperament and the development of prelinguistic communication

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Details

The index-finger pointing gesture represents a crucial milestone in infant communicative development, which has been linked to subsequent language development (Colonesi et al., 2010; Lüke et al., 2017). While the importance of interactional experiences with caregivers has been highlighted (Salomo et al., 2013, Rüther & Liszkowski, 2023), the contribution of infant-internal factors to the considerable variability in the age of emergence remains poorly understood (spanning from 9 to 15 months). Prior research indicates that individual differences in temperamental positivity/surgency and negative affectivity might influence communicative development. For example, infants high in positive affectivity have been reported to engage more in referential interactions and joint attention, potentially facilitating pointing development (Vaughan et al., 2003, Ollas et al., 2020, Salvadori et al., 2022). In contrast, the "Fearful Ape Hypothesis" proposes heightened fearfulness to elicit more social interactions between caregivers and infants, which might increase learning opportunities (Grossmann, 2023). However, empirical findings concerning links between negative affectivity and communicative development vary, reporting positive, negative, or no associations (Nichols et al., 2002, Vaughan et al., 2003, Sally et al., 2007, Ollas et al., 2020). To address this gap, we investigated whether temperamental surgency and/or negativity are associated with differences in the development of the pointing gesture.

Infant temperament was evaluated through parent reports at 7.5 months (IBQ-R, Gartstein & Rothbart, 2003), and live observations during a laboratory visit at 9 months. The 9 months visit included the presentation of four Lab-TAB episodes designed to elicit either joyful (puppet game, interesting lamp with music) or fearful (stranger approach, scary masks) responses from infants (Goldsmith & Rothbart, 1996). Overall joy or fear intensities were coded for each episode (ranges: 0-3). Additionally, EEG was collected while infants watched an interesting video (resting state) to measure frontal EEG asymmetry in alpha power (FAA). Resting FAA has been associated with a dispositional tendency towards positivity/approach versus negativity/withdrawal (Degnan et al., 2011). The onset of pointing was assessed through monthly parent reports between 8 and 13 months and during a lab visit at 11 months,

which involved the exploration of an interesting room by infants and parents (Decorated Room paradigm). Our study sample comprised 132 infants (pre-exclusions). Analysis of parent-reported infant temperament revealed a significant positive association between infant fearfulness and index finger pointing frequency at 11 months ($r(113) = 0.27$, $p = 0.003$). Behavioral coding for the Lab-TAB episodes has not been completed yet. An association between joy intensity during the puppet episode and index-pointing frequency just failed to reach significance in a preliminary analysis ($r(75) = -0.22$, $p = 0.06$). No significant associations emerged between infant temperament and the age of pointing onset (FAA, Lab-TAB, or IBQ-R scales). Additionally, no differences in temperamental positivity or negativity were observed between pointing and non-pointing infants at 11 months (unpaired t-tests, pointing = at least 2 observed points). Pending final analyses, we suggest that the onset of pointing is not driven by temperamental differences. However, once pointing has emerged, infants higher in fearfulness engage more often in referential exchanges with their parents.

P3-E-525 - Newborns' sensitivity to pointing action as an ostensive communicative signal: a pilot study

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Details

Pragmatic theories assume that humans evolved a species-unique inferential capacity to express and detect intentions via communicative actions (Grice, 1957; Sperber & Wilson, 2002). Recent studies provided evidence that 6-to 13 month-olds recognize communicative interactions between third parties via turn-taking exchange of tone sequences or speech sounds by inferring communicative intentions (Martin, Onishi & Vouloumanos, 2012; Tauzin, & Gergely 2018; Vouloumanos, Onishi, & Pogue, 2012). Interpreting pointing action involves an understanding of others' intentions, attention, and knowledge states (Aureli, Perucchini, & Genco, 2009; Camaioni, Perucchini, Bellagamba, & Colonnesi, 2004; Csibra & Gergely, 2011; Franco, Perucchini, & March, 2009; Gergely & Jacob, 2012; Liszkowski, 2018). By around 12 months of age, infants point meaningfully to intentionally guide others' attention to entities and events, and by 20 months of age infants' pointing is a communicative, referential act, used flexibly across a range of situations for various purposes (Liszkowski & Ruether, 2021).
Here we investigate for the first time whether newborns manifest an attentional bias toward a pointing action. Using a preferential visual paradigm, we explored 5-day-old newborns' visual reactions to a pointing toward a target and to a fist directed toward the same target. Newborns looked longer toward the pointing compared to the action involving the fist. Our results show that newborns are sensitive to pointing gestures, suggesting a predisposition to develop an early understanding of communicative intentions and other mental states.

P3-E-526 - Developing interactive and multisensory joint attention: A longitudinal study with toddlers at 12, 18, and 24 months of age

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Details

Traditionally, the focus of JA research has been on the skills children acquire rather than the communicative interactions where those skills emerge.

This study aims to explore the development of JA within the communicative interactions between children and their parents, with the focus on the interactions and how these change from the first to the second year of life.

Fourteen parent/child dyads were video-recorded at home in a standard 10-min, free-play situation. Parent/Child (P/C) interactions were recorded at three-time points (12, 18 and 24 months of age). Thirteen mothers and one father participated; nine girls among the toddlers.

P/C interactions were coded following Garbouer and Bortfeld´s (2021) criteria to identify JA sequences (units). These include 3 defining elements (at least one attentional bid, one response and one verification behaviour) and two temporal constrains (a minimum 3´´-sequence duration and a maximum 5´´-delay between elements). We analysed: (1) both the rate per minute of each element and the rate of JA sequences across the three time-points and (2) the rate and duration of "JA episodes" (at least two consecutive JA sequences) as indicative of complexity and sustained JA. Finally, we analysed the extent of multi- and unimodal- bids and responses by each agent.

Changes in JA sequences and their complexity All interactive JA measures increased with age. The rate of JA sequences was lower at 12-months (mean=1,337) than at 18- (mean=1,614) (t(13)= -2,399*) but no different between 18- and 24-months. The rate and duration of JA episodes also increased with age (see fig. 1), showing significant differences in the rate of episodes between the ages of 12-moths and the ages of 18- (t(13)= -2,638*) and 24-months (t(13)= -3,920**). Episode duration was longer at 24- than 18-months (t(13)= -4.488**).

*Multimodality of bids in the JA sequences as a function of age and agent:*A series of two-way, 2 (type of modality: multi, uni) x (3 , age: 12, 18 & 24 months), mixed ANOVAs on the rate of bids by each agent were performed. Analyses showed a main effect of modality (parent: F(1,13)=127.094**; child: F(1,13)=38.755**) but no main effect of age for either parent's or children's bids; for both, the mean rate of multimodal bids was higher. Parent´s bids, however, showed a significant interaction between age and modality; parent´s multimodal bids decreased between 18- and 24-months while unimodal bids increased from 18 months (see fig. 2). Interestingly, all "unimodal" bids by parents were vocal/verbal.

Findings indicate: (1) Significant changes in the rate and complexity of JA interactions with age. At 18 months JA interactions increase significantly; between 18 and 24 complexity increases, particularly, in the duration of sustained JA. (2) Both parents and children produce more multimodal than unimodal bids, irrespective the age of the child. Parents, however, increase unimodal-verbal bids with children at 18 and 24 months (interestingly coinciding, with vocabulary spurt). Further analyses are underway. So

far, however, we can conclude the JA develops as an interactive and multisensory process between the first and the second year.

P3-E-527 - Child temperament profiles and language development in toddlers: which relation?

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Details

Recent studies have started gathering evidence on the hypothesis of a link between child temperament and language trajectories (Bruce et al., 2022; Ishikawa-Omori et al., 2022; Pérez-Pereira et al., 2016). The literature, however, still lacks an understanding of the components of child temperament that are related to language skills, and of the individual/environmental variables that might influence such a relationship.
The present study contributes to this research field by investigating this association in a longitudinal sample composed of 166 children (75 females and 91 males) with (n = 57) and without (n = 109) family history of Language and Learning Impairment (LLI).
Early temperament was measured at 24 months by means of an Italian version of the Early Childhood Behaviour Questionnaire (ECBQ) (Cozzi et al., 2013). Longitudinal language skills were assessed at 20/24/36/48 months through standardized language assessment tools and ad-hoc tasks.
Possible associations between temperament subscales and language skills were initially explored through preliminary correlation analyses. As an example, Figure 1 shows the heatmap of the correlations between ECBQ subscales and factors, and the subscales of the Children's Communication Checklist (CCC-2) (Bishop, 2003), filled up by parents when children were aged 48 months. A latent profile analysis on the ECBQ factors was then performed and post-hoc comparisons were used to examine how the temperament profiles differed in relation to their longitudinal language scores.
The results of the analyses show that the children of our sample are effectively represented by two distinct temperament profiles: the first profile (n = 42), characterized by low negative affectivity and surgency, and high effortful control, and the second profile (n = 124), whose children exhibit the opposite pattern (see Figure 2). The two profiles significantly differ (at $p \leq 0.05$) with respect to their language outcomes at 48 months (CCC-2 subscales of syntax, use in context, non-verbal communication). It is the first profile, in particular, that scores lower in these language assessments, suggesting that a temperament characterized by low effortful control, and high negative affectivity and surgency at 24 months might represent a risk factor for language development later on. In our sample, environmental variables such as familiarity for language and learning disorders, parents' education, SES, home literacy and family structure have comparable influence across profiles.
Despite its exploratory nature, this study provides some preliminary evidence on the association between child temperament profiles in toddlers and later language development. Future studies should investigate this research question more in depth, possibly analysing the influence of the specific dimensions of temperament on longitudinal language outcomes. A more thorough assessment of language skills should be considered, too.

This research study falls within the scope of the ICIS Founding Generation Summer Fellowship for Undergraduates 2023.

P3-E-528 - Looking for the roots of affect and intention in sound perception: Dissonant sound modulates pre-babbling infant attention to kiki and bouba animations

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Details

Introduction: Vocal exchanges between caregivers and young infants present inter-turn relationships equivalent to musical intervals, which can be described as consonant or dissonant, with the latter associated with breakdowns in the interaction (Van Puyvelde et al., 2010, 2013, 2015). Dissonant/consonant sounds are clearly differentiated in young infant perception, with consonant (pleasant) sound associated with sustained attention and dissonant (unpleasant) sound instead associated with loss of attention and increased motor agitation (Zentner & Kagan, 1996; Trainor et al., 2002).

Responses to *kiki/bouba* visual stimuli have been attributed to cross-modal associations with articulatory patterns (reviewed in Vainio & Vainio, 2021) that only post-babbling onset infants would have experience of (but see Ozturk et al., 2013). However, prelinguistic preferences for *bouba* shapes may be mediated by musical rather than phonological properties of sound.

Given the literature supporting [i] the emotional mapping of cross-modal associations such as *kiki*/negative and *bouba*/positive (Blazhenkova & Kumar, 2018) and [ii] infant preference for consonant sounds, we expected that the deployment of infant attention to *kiki* or *bouba* animations would be modulated by sensorial dissonance even in pre-babbling infants, with an expected implicit association of *bouba* ('positive') with consonance and of *kiki* ('negative') with dissonance.

Method: We presented four types of equivalent black & white animations (30 sec.) in which abstract *kiki* (spiky) or *bouba* (round) shapes were moving around the screen coupled with tonal sequences characterised by consonant or dissonant single harp tone intervals (Bravo et al, 2017, 2020), see Figure 1; control trials were silent. Infants aged 4-9 months (N=61) were individually tested in a sound-attenuated booth with Bosch loudspeakers. The dependent variable was the total looking time (sec.), as measured by the Tobii X-120 Eye-Tracker.

Results: Silent trials (control) did not present any significant preferences for either *kiki* or *bouba* animations *per se*. A 2 shape X 2 tonal sequence X 2 age group (4-6 vs. 7-9 months) ANOVA revealed only a significant interaction shape X tonal sequence, indicating a pattern of attention consistent with

violation of expectation: superior attention was measured in 'incongruent' animations: *bouba* animations with dissonant sound and *kiki* animations with consonant sound, see Figure 2.

Conclusion: Results are discussed as providing novel evidence on the grounding of early communication in affective primitives, with an early association of dissonant sound with negative affect / intention.

P3-E-529 - Cross-cultural differences in language acquisition input in Asian and Western cultures

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Details

Mothers' speech to infants constitutes a primary input for early language learning. Yet the way mothers talk to infants can differ across cultures. Fernald and Morikawa (1993), for example, reported that when asked to interact freely with their infants, mothers from the US spent more time directing infants' attention to objects and their names, whereas Japanese mothers directed infants' attention to the emotions and experiences of the infant in relation to the objects. When Senzaki et al. (2014) asked mothers to describe a picture of fish in a tank to their child, Canadian mothers tended to talk more about the focal object (the fish), while Japanese mothers focused more on the background. These differences in communicative styles could impact the way children in each culture acquire language.

To examine whether systematic differences occur reliably across cultures, we collected two types of mothers' speech to 18-month-old infants. In the Infant-directed Speech (IDS) task, mothers were asked to teach their infants the 'names' (nonsense words) of soft toys. In the Scene Description task (SD task) mothers were asked to describe three scenes presented on a monitor: "Fish-tank" (following Masuda & Nisbett, 2001; Senzaki et al., 2014), "Neutral," where the focal character(s) are in front of a simple background, and "Emotional," in which two characters show positive and/or negative emotions.

Preliminary analyses of IDS results from 6 Japanese and 2 American mothers found that American mothers produced significantly more utterances involving 'naming' the object or asking the name (49.6%) compared with Japanese mothers (31.4%, $p<.001$). This finding is consistent with previous studies (Okumura et al., 2016; Fernald & Morikawa, 1993).

In the SD task, data for 5 Japanese and 2 French mothers were coded. Preliminary results did not show a different pattern for French and Japanese mothers' descriptions of the focal objects or background information in the fish-tank scenes (40%, 43%, respectively). With the neutral scenes, however, the Japanese mothers focused more often on the main character than did the French mothers (66% vs 45%). These results differ from those of Senzaki et al. (2014). However, as in Fernald and Morikawa (1993), the Japanese tended to talk about the children's experiences related to the images rather than merely

describing the images.

While the results of our IDS study were consistent with previous work (Fernald & Morikawa; Okumura et al., 2016), the SD study findings were not consistent with Senzaki et al. (2014). Given that our SD results compared Japanese and French mothers, the inconsistency may have arisen from the difference between Canadian and French mothers, indicating a potential variation among so-called "Western" cultures. We expect to complete the analysis of the full data by July 2024 and will then be able to present.

P3-E-530 - How do mothers and children initiate conversational exchanges?: The dynamics of multimodal cue usage in beginning vocal exchanges across child development

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Details

How do mothers and children initiate conversational exchanges? While verbal communication traditionally marks the onset of dialogue (Chai et al., 2022; Salo et al., 2022), non-speech multimodal cues, such as gestures (Caselli et al., 2012) or touch (Ko et al., 2023), often precede spoken interaction. This paper investigates the pivotal role of non-verbal cues in initiating verbal interactions, exploring how their usage adapts with child age and language proficiency, and examines the potential effect of agentivity in multimodal communication dynamics. Specifically, we test the hypothesis that the use of multimodal, non-verbal cues declines with child age and language development, potentially indicating a transition from non-verbal to verbal communication as language skills mature. Furthermore, we explore whether initiators of conversation will exhibit a higher proportion of cues compared to respondents, as observed with speech patterns in previous research (Ko et al., 2016).

This study utilizes audio-visual recordings from the Ko Corpus of Korean mother-child interaction in CHILDES (Ko et al., 2020). The corpus consisted of dyads at varied developmental stages (N = 35, girls = 14; Age in months: M = 16.19, SD = 8.18, range = 6 - 30), with each participating in a 40-minute free-play session. We identified multimodal cues (gestural, looking, pointing and tactile cues) preceding conversational blocks, defined by an interval of 5,000 ms of silence (Hart & Risley, 1992). In addition, we collected children's language outcomes using the SELSI inventory in comprehension and production.

We employed a binomial linear mixed model to analyze the effects of block type, age, and gender on cue presence, with the random intercept for nested conversational blocks within subjects. We found a significant three-way interaction ($p = .019$), indicating an age-related decrease in cue usage, except in child-initiated blocks by boys (Figure 1). In the second model, the two-way interaction between block type and cue actor ($p < .001$) revealed that children and mother tend to produce more cues in own-initiated blocks than in those initiated by the other ($ps < .001$). When investigating the relationship

between non-verbal cues and language outcome, we found a significant interaction between SELSI receptive vocabulary score, block type and cue actor (p = .035). The results indicate a negative relationship between children's cues and SELSI comprehension in mother-initiated blocks but weaker trend in child-initiated blocks; whereas mothers tend to produce less non-verbal cues in both block types (Figure 2).

This study's integrated analysis of verbal and non-verbal elements shed light on the nuanced interplay between multimodal cues and language development in mother-child interactions. Findings reveal a shift from non-verbal initiation of conversation to verbal as children age, with initiator roles influencing the use of multimodal cues. The decline in non-verbal cues within mother-initiated interactions as children's vocabulary grows signifies a key developmental shift towards favoring verbal over non-verbal communication for initiating exchanges, mirroring the observed age-related variation.

P3-F-531 - How infants' face sensitivity and object exploration during the Face pop-out task relates to their vocabulary outcomes

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Details

Introduction: Infants' learning is guided by the social information present in their environment. Therefore, how infants sample their surroundings may impact their word learning. We set out to explore whether infants' sensitivity to faces and object exploration at 4-7 months has long-lasting effects, and may relate to their vocabulary outcomes at 2.3-4.0 years.

Method: The current data are part of the YOUth study, a longitudinal cohort following children's developmental trajectory (Onland-Moret et al., 2020). In total, 241 children (109 boys) participated at both time points (pre-registration: https://osf.io/4eunr). Using eye tracking, infants' face sensitivity and object exploration were calculated during the Face Pop-out paradigm, a free viewing experiment where infants are presented with displays of six objects including a face (Gliga et al., 2009). This task yielded 3 (related) measures of face-sensitivity as well as 1 measure of how many objects on average were attended to during the display (object exploration score). In early childhood, the same children's vocabulary outcomes were assessed once using the Peabody Picture Vocabulary Task (PPVT; Dunn et al., 1965; Schlichting, 2005). Because the age range of the childhood wave spanned 2.3-4.0 years, we used the normed word comprehension quotient (WBQ) scores as outcome measures. Next, we ran separate moderation analyses on each of the predictor variables to observe whether there was a relation with the outcome variable, and whether this relationship was moderated by the age at which the PPVT was administered.

Results: We observed stronger relationships for object exploration than for any of the face-sensitivity measures. Crucially, there was a 2-way interaction between object exploration and age of testing on the PPVT (B = -0.12, p = .025). For a gradient plot of the interaction, see Figure 1. The plot shows that if the children were younger when they were tested on the PPVT, there was a positive correlation

between their predictor and outcome scores – the higher the object exploration of the child was, the higher their vocabulary norm scores. However, when the children were older, this relationship seemed to wane: there was less correlation between object exploration and vocabulary norm scores.

Conclusions: Infants' object exploration was found to relate more strongly to vocabulary outcomes early in childhood. An explanation could be that younger children have smaller receptive vocabularies to utilize when learning new words, and they may therefore rely more on other mechanisms for word learning, such as their capacity to visually explore an environment.

P3-F-532 - Broad Autism Phenotype and parental sustained attention during parent-infant play

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Details

Parental characteristics, such as stress, anxiety, and depression have been well-documented to influence parent-child interactive engagement, including parental sensitivity, emotional availability, and responsiveness [1-6]. Recently, a range of autistic traits – broad autism phenotype (BAP) traits – have been linked to parental interaction behaviors, such as affect and emotion regulation [7-8]. Though these studies recorded several parental behaviors, we know little about attention behaviors, which have been shown to play a critical role in establishing advanced social-communication behaviors with their child. The present study explored the relationship between BAP traits and parental sustained attention in a parent-infant object play context.

Method: 25 parent-infant dyads participated in the present study (11 male infants, 15 female infants, *M* age = 8.67 months, *SD* age = 2.89 months, *M* household income = $127,569.15, *SD* household income = $68,4440.93, 10 White, 8 Hispanic, 3 Biracial, 2 Black, 2 Asian). Parents and infants wore a head-mounted eye-tracking device (Figure 1) while completing a six-minute parent-infant play session with six unique toys. In the present analysis, only parent views and gaze data were coded frame-by-frame for what targets they looked at (objects, parent hands, infant hands, and infant face). Frequency, duration, and average duration were calculated for sustained attention (moments when the parent looked at a target for at least 2000 milliseconds) [12]. Parent participants completed the Broad Autism Phenotype Questionnaire (BAPQ) [13] which consists of a total score and three subscale scores for characteristics associated with the primary diagnostic domains of autism: 1) aloofness, 2) rigidity, and 3) pragmatic language. The questionnaire consists of 36 items, each rated on a six-point Likert scale (ranging from "very rarely" to "very often"). The BAPQ is suitable for assessing traits in individuals without an autism diagnosis, with higher scores indicating more prevalent BAP characteristics.

Results: A series of linear regression analyses were conducted to test the relationship between BAPQ scores and each measurement of sustained attention. Results indicate that: (1) the total score (*M* = 2.49, *SD* = 0.62) was negatively associated with sustained attention average duration ($R2$ = .19, $F(1,24)$ = 5.49, p = .028, β = -399.67). (2) Aloofness (*M* = 2.48, *SD* = 0.87) was negatively associated with sustained attention duration ($R2$ = .19, $F(1,24)$ = 5.27, p = .031, β = -5580.99) and average duration ($R2$ = .24, $F(1,24)$ = 7.5, p = .011. β = -319.59). (3) Rigidity (*M* = 2.67, *SD* = 0.64) was negatively associated with sustained

attention average duration ($R2$ = .12, $F(1,24)$ = 3.3, p = .042, β = -310.33). Scores in the pragmatic language domain (M = 2.33, SD = .076) were not associated with sustained attention.

The findings of differential parental sustained attention behaviors based on BAPQ scores raise a larger question of how other parental background factors contribute to early parent-infant interactions and how these can be leveraged for developing and improving parent-mediated interventions that focus on social communication. Future research should explore the relationship between BAP traits and other parental play behaviors, such as speech patterns and object handling.

P3-F-534 - The effect of intersensory redundancy on the neural correlates of face recognition in 12-month-olds: An ERP study

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Details

Background: Infant social interactions typically take place in multimodal settings, where social partners are seen and heard. This synchronous audiovisual stimulation possesses intersensory redundancy (IR), which elicits infant attention and promotes processing of information not specific to a certain sense modality (i.e., information presented across multiple sense modalities) (Bahrick & Lickliter, 2000; Curtindale et al., 2019; Flom & Bahrick, 2007). Event-related potentials (ERPs) can provide insight into the role of IR in infants' attention and processing of faces. The N290 and P400 are ERP components indicative of developing face specialization (e.g., Guy et al., 2016; Conte et al., 2020). The Negative central (Nc) ERP component provides insight into attention allocation and stimulus salience (Guy et al., 2016).

Objective: This study examines neural responses to faces presented with and without IR to understand its impact on face processing and recognition in 12-month-old infants.

Method: Twelve-month-old infants are actively being recruited for this study. Participants first complete a familiarization phase including videos of two actors reciting children's stories. One of the videos possesses IR (i.e., synchronous audiovisual presentation), while the other does not (i.e., asynchronous audiovisual presentation). Following familiarization, ERPs are measured to 500 ms presentations of the face presented with IR (i.e., familiar-synchronous), the face without IR (i.e., familiar-asynchronous), and a novel face. ERPs are recorded using a Magstim EGI 128-channel EEG recording system. Data collection and processing are ongoing, and data have been collected from 9 participants. We expect to have a complete data set (i.e., useable data from 20 infants) by spring 2024.

Data analytic plan: ERPs will be segmented from 100 ms before stimulus onset through 1,000 ms following onset. Peak amplitude of the N290 and P400 and mean amplitude of the Nc will be analyzed using methods described in our previous research (Conte et al., 2020; Guy et al., 2016; 2021). The analysis will include within-subjects factors including stimulus type (synchronous-familiar, asynchronous-familiar, novel) and electrode location (vary by component). Repeated measure ANOVAs

will be used. Significant effects will be examined with one-way ANOVAs, paired-sample t-tests will be run, and calculation of least squares means with Bonferroni corrections for multiple comparisons.

Hypotheses: Infants are expected to attend more to the synchronous face than the asynchronous face during familiarization, as synchrony is expected to attract infants' attention. However, IR is expected to direct attention to information that is presented across both audio and visual sense modalities, inhibiting modality-specific (i.e., visual-only) face processing. Infants are expected to attend to and process characteristics of the asynchronous-familiar face because it does not possess IR. This will be reflected in a smaller amplitude Nc response to the familiar-asynchronous than the familiar-synchronous face presentations. The Nc is expected to be equivalent across familiar-synchronous and novel face presentations. We expect to see an N290, but we do not expect it to vary across different stimulus types. The P400 will be examined exploratorily, as past literature has shown conflicting findings regarding its role in face processing (e.g., de Haan et al., 2002; Halit et al., 2004).

P3-F-535 - The speed of object recognition in the first year of life

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Details

Current research findings point towards two major mechanisms that can account for cognitive development, from the very first weeks of life through adulthood. One is a remarkable acceleration of visuo-attentional processes from early infancy to adulthood (Hochmann & Kouider, 2022), possibly linked to the progress of cortical myelination and brain maturation in the first months and years of life. The other is an increment in the integrative capacity upon visual stimulation: as infants grow old, they appear to integrate more and more visual features leading to the ability to represent more and more visual categories (Spriet et al., 2022). Here, we show that these two developments are related: as infants grow older, visual processes get faster facilitating the integration of visual features to represent object categories.
Using frequency-tagging electroencephalography (EEG), we targeted an automatic and implicit categorical response to animate vs. inanimate images, as a measure of visual object categorization in adults and in 4- and 9-month-old infants. Images (640 different animate or inanimate objects) were presented at a regular, base frequency (Fb), within streams where rare target images from one category (e.g., animate) were regularly intermixed with images of the other category (inanimate) at the target frequency Ft = Fb/5 (Figure 1A). Effective categorization is signaled by increased spectral power at Ft and harmonics (Figure 1B). Under the hypothesis that processing speed accelerates over time we tested the limits of object (animate-inanimate) categorization at different ages, by varying the stimulus presentation rate Fb. Adults (n = 36) were tested with Fb = 6, 12 or 30 Hz; 4-month-olds (n = 64), with Fb = 4 or 6 Hz; and 9-month-olds (n = 64), with Fb = 6 or 12 Hz.
We used the baseline-corrected response amplitude at Ft (and harmonics) as a measure of categorization. Results revealed that, consistently across age-groups, the categorical response (a spectral response at Ft and harmonics) decreased as the stimulation frequency increased. In adults, this

response decreased from 6 to 30 Hz, although it remained significant even at 30 Hz (Figure 2A); in 9-month-olds, the response decreased from 6 to 12 Hz, although it remained significant even at 12 Hz; in 4-month-olds, the response was found at 4 Hz but decreased until it disappeared at 6 Hz (Figure 2B). The response appeared to be equivalent for 4-month-olds at 4 Hz and 9-month-olds at 12 Hz, showing that 9-month-olds process categories ~3 times faster than 4-month-olds. These results demonstrate a dramatic acceleration of visual categorization, a process relying on feature integration, in the first year of life. This acceleration continues into adulthood.
Based on these results, we propose a model where, as the processing speed accelerates, more and more visual features activated by visual stimulation can be integrated before they decay, yielding more efficient and richer categorization. We also discuss how, at the same time, slow perception may be advantageous in early infancy, filtering out overstimulating variable information, in favor of more basic and stable information that reveals the structure of the world.

P3-F-536 - The development of rapid face categorization: Evidence from frequency-tagging EEG in a large cohort of infants, children and adults

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Details

Perceiving faces within a fraction of seconds is of outmost importance for humans across the lifespan. Face perception follows a protracted development, starting from a broad sensitivity to face(like) patterns already from the womb (Reid et al., 2017) to the fine-grained perception of a variety of subtle facial dimensions (e.g. identity, age, sex, expression; e.g., Pascalis et al., 2011; Rossion, Retter & Liu-Shuang, 2020), relying on an extended neural network along the ventral occipitotemporal cortex (e.g., Grill-Spector et al., 2017). To study the development of face perception, scalp electroencephalography (EEG) has been routinely used. However, standard EEG approaches make it difficult to extract comparable information across developing populations. Here, we report the development of face-selective neural activity using frequency-tagging EEG to isolate a neural marker of rapid face categorization across age groups. We gathered published and novel data collected in 5 age groups (N=140 in total): 4-to-6-month-olds (N=27), 8-to-12-month-olds (N=26), 5-year-olds (N=33), 10-year-olds (N=27) and 22-year-olds (N=27). All groups were exposed to similar fast periodic visual stimulations using natural images (i.e., where the main item is viewed from different viewpoints and embedded in variable backgrounds). Various face exemplars were presented at a fixed interval within streams of nonface stimuli to tag 2 distinct neural responses at distinct frequencies and harmonics (integer multiples): a general visual response to all stimuli (6 Hz) reflecting basic visual function and a face-selective response (1.2 Hz) reflecting rapid face categorization across various faces. We analyzed the data following an identical pipeline across all groups, in order to provide direct quantitative and qualitative analyses of the development of rapid face categorization from infancy to adulthood. Results show that while the face-selective response is already present in the youngest infants, its amplitude increases with age at lateral posterior regions, reaching a maximum in children. The response is observed on a single harmonic at 4-6 months (at group and individual levels) and becomes progressively

distributed on more harmonics in a linear fashion, reflecting a mono-component slow response starting from 245 ms after stimulus-onset at 4-6 months that evolves to a faster (from 115 ms) multi-component response in adults. The response is also more and more reliable across participants with age. In contrast, the general visual response is reliably high from the youngest age tested, with a comparable distribution across harmonics and age, and a shared topographical distribution. Combined together, these results highlight the maturational changes of the visual system and the tuning of the face-selective network with development. Thus, using the same approach across age groups, we are able to characterize quantitatively and quantitatively the development of a neural signature of rapid face categorization from infancy to adulthood at both group and individual levels.

P3-F-537 - Curious Choices: Infants' moment-to-moment information sampling is driven by their exploration history

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Details

Infants explore the world around them based on their intrinsically motivated curiosity. However, the cognitive mechanisms underlying such dynamic curiosity-driven exploratory behavior remain largely unknown. Here, infants could freely explore two novel categories, triggering a new exemplar from a category by fixating on either of the two associated areas on a computer screen. This gaze-contingent design enabled us to distinguish between exploration – switching from one category to the other – and exploitation – consecutively triggering exemplars from the same category. Data from N=68 typically developing infants (age range: 10-12 months, M = 11.1, SD = 0.52, 50% female) indicated that they structured their exploration non-randomly, but that in-the-moment sampling choices were guided by the infants' exploration history. A cluster analysis of three variables characterizing the self-generated sequences (overall engagement, switch-proportion, and category entropy) grouped into three clusters of more explorative (n = 9), exploitative (n = 23), and balanced (n = 36) sampling patterns, which were not significantly related to the infant's age or sex. Importantly, Bayesian hierarchical binomial regression models indicated that across sequence patterns, infants' longer trigger time (estimated mean effect ^b = 0.17, 95%-Credible Interval(CI)[0.02; 0.32]), more gaze-shifting (^b = 0.16, 95%-CI[0.00; 0.31]), and marginally shorter looking time (^b = -0.04, 95%-CI[-0.20; 0.13]) were associated with a higher likelihood to disengage from exploiting one category and making an exploratory switch to the other (Figure 1), especially after consecutively viewed stimuli of high similarity. Additionally, a newly developed and validated caregiver report for infant trait curiosity could explain some variance in how infants structured their exploration (N=32), so that infants of medium curiosity made the most triggers, and that more curious infants tended to switch more between the categories. Together, these findings offer novel insights into infants' dynamic curiosity-driven exploration, employing a powerful new paradigm which can capture both, intricacies of moment-to-moment sampling choices, but also more global patterns of exploration linked to individual differences in trait curiosity.

P3-F-538 - Curiosity-driven learning in infants has long-term implications for their later cognitive performances

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Details

Infants acquire knowledge about the world at an extraordinarily quick pace. Over the years, researchers have dedicated extensive efforts to predict later cognitive functioning from infants' early learning skills (Kavšek, 2004). So far, however, little is known about a promising candidate process that may contribute to later cognitive functioning, curiosity-driven learning. Curiosity-driven learning is characterized by infants actively engaging with their environment, optimizing attention allocation to stimuli that offer opportunities for information gain (Kidd et al., 2012; Addyman & Mareschal, 2013; Bazhydai et al., 2020; Poli et al., 2020). Intriguingly, individual differences in curiosity-driven learning are evident, even at a young age (Poli et al., 2023). Here, we show that these interindividual differences in infants' sensitivity to information gain – a key aspect of curiosity-driven learning – have long-term consequences for their cognitive development.

In a longitudinal study, we investigated the relationship between infants' sensitivity to information at 8 months and childhood intelligence 3 years later (n=60, 50% female, see Figure 1 for an overview). At 8 months, we measured infants' sensitivity to information with an eye-tracking paradigm. Infants were shown multiple sequences of cue-target trials with each trial containing different amounts of information. A hierarchical Bayesian model allowed us to assess infants' sensitivity toward information by relating their looking time to each stimulus with the amount of information provided by that specific stimulus (Poli et al., 2020). Interindividual differences were evident. Upon reaching 3 years of age, children's intelligence was evaluated using the standardized WPPSI-IV-NL intelligence test (M=106, SD=12.6, N=60). We used a generalized additive model to relate individual differences in infants' sensitivity toward information with childhood IQ, while controlling for differences in socio-economic status (SES). We showed that individual differences in infants' sensitivity to information is significantly related to childhood IQ (F=3.87, edf(effective degrees of freedom)=3.584, p=.006), explaining 22% of the variance in childhood IQ (Figure 2).

This is the first evidence linking the degree of curiosity-driven learning in infancy to later cognitive outcomes, shedding light on the long-term consequences of how infants navigate learning opportunities in an information-rich world. In addition to the speed with which infants process information (Kavšek, 2004), our study extends previous research by demonstrating that how infants process information and what aspect of their environment they are sensitive to also plays a pivotal role in early cognitive development. Benefitting from this discovery, the impact for developing ways to stimulate curiosity is promising to enhance exploratory behavior and, ultimately, support lifelong learning.

P3-F-539 - Dynamics in caregiver-infant interactions shape adaptive infant attention

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Details

Recent work has provided evidence that: a great deal of structural brain organization occurs during infancy (Johnson et al., 2015); early experiences may lay neural foundations for either lifelong pathology or wellness (Karmiloff-Smith et al., 2018); and humans are an altricial species that depends on caregivers for learning and survival early in life (Tottenham, 2012; Werchan & Amso, 2017; Tummeltshammer et al., 2019). How caregivers shape emotional development is well-studied, but the ways in which they shape cognitive development are less understood. Here, we address two possible mechanisms: caregiver childrearing goals held in mind for action during dyadic interactions and caregiver (un)predictability patterns. In human and animal models, unpredictable fragmented caregiving has shown to be associated with altered cognitive outcomes (Davis et al., 2017), but the underlying mechanisms are not yet clear. Furthermore, previous work has shown caregivers structure interactions to actualize childrearing goals (Harwood et al., 1999; Ng et al., 2012), but the impact of behavioral manifestations of childrearing goals on infant attention and learning are not articulated. Here, we use at-home recordings of caregiver-infant interactions during a standardized cognitive assessment (DAYC-2). We developed a novel coding scheme to annotate moment-to-moment change in a host of verbal and non-verbal maternal and infant behaviors. Additionally, we collected caregiver demographics and caregiver childrearing goals using the SGI (Harwood et al.,1996). Using these data, we test the following hypotheses: 1) variability in caregiver childrearing goals will be associated with caregiver characteristics; 2) distribution of caregiving behaviors will vary as a function of caregiver-stated goals; and 3) caregivers who have childrearing goals that are aligned with their behavioral patterns, and whose moment-to-moment behavioral patterns are predictable, will have infants who show high levels of attention to the caregiver during interaction. Mother-infant (8- to 11-month-old infants) dyads (N=95) were recruited as a part of the COVID-19 Mother Baby Outcomes initiative and voluntarily participated in this sub-study. We found caregiver childrearing goals vary as a function of caregiver characteristics, specifically ethnicity (N=83) and educational attainment (N=75). Only maternal verbal feedback behaviors (N=76) demonstrated to vary as a function of caregiver goals ($F(2,73)=3.96$; $p=0.02$). Mothers whose goals were to endorse qualities of connectedness and lovingness offered the most verbal feedback to their infants. When examining infant visual, verbal, and physical attention to their caregiver (N=72), we found only caregivers who highly endorse Self-Control have infants who verbally attended to them while providing discouraging structure ($F(2, 68)=5.45$; $p=0.006$). Additionally, we examined whether maternal (un)predictability was related to infant attention and found infant looking time to be both linearly (β = 662.1, SE=115.5, $t(2196.7)=5.731$, $p<0.000$) and quadratically (β =-242.3, SE=108.2, $t(2196.7)=-2.239$, $p<0.025$) related to within-caregiver entropy values across 20-second time windows. This suggests infants are the most attentive to their caregiver when they are neither highly predictable nor highly unpredictable. This pattern, however, did not vary by maternal child-rearing goals. Taken together, this study supports the hypothesis that caregiving dynamics during dyadic interactions vary by caregiver childrearing goals and play a role in shaping developing infant attention systems.

P3-F-540 - Thriving in chaos: Higher CHAOS predicts better attentional control in 3-month-olds with more depressed mothers

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Details

Household chaos, or the extent to which a home has high levels of disorder and excessive cognitive "noise," has been associated with negative child, parent, and family outcomes in a great number of studies (for review see Marsh, Dobson, & Maddison, 2020). Maternal depression has similarly been found to be a risk factor for child development with wide ranging implications (for meta-analysis see Goodman et al., 2011) and both household chaos and maternal depression are largely theorized to have an unambiguously negative impact on child development.

However, the relationships between CHAOS and infant outcomes can be quite nuanced. Namely, we found that the expected association between CHAOS and infant resting cortisol at 5 months of age (N = 75) was only significant for infants raised in homes without other children, see Figure 1. In fact, for infants with other children in the home CHAOS was marginally associated with lower resting cortisol. Due to the unexpected and marginal nature of that result, it must be interpreted with caution, however, it could suggest that in some contexts (particularly in low-risk families) CHAOS could be a proxy for some types of positive enrichment. These results indicated the source and context of the CHAOS matters (e.g., elevated noise and disorder due to the presence of more children may be fundamentally different than noise and disorder due to other sources such as marital conflict).

To further this line of inquiry we examined the relationship between CHAOS and cognitive development (namely attentional control indexed via average fixation duration whereby shorter average fixation durations are interpreted as stronger attentional control as in White et al., 2022). We were again interested in whether contextual factors change the impact of chaos on infant outcomes so we examined the interaction between CHAOS and maternal depression on infant attentional control. The rationale for this model was that if in some contexts CHAOS is tapping into enrichment, then the effect of maternal depression could reverse between infants experiencing higher or lower levels of CHAOS (specifically, the context of higher CHAOS could serve as a buffer to the effect of flat affect often exhibited by more depressed mothers on infant cognitive development). Consistent with our hypotheses, the data (N = 79) revealed a significant interaction between maternal depression and CHAOS on infant average fixation duration, see Figure 2. For infants exposed to lower levels of CHAOS, higher levels of maternal depression were associated with significantly longer average fixation durations (indicative of poorer attentional control). In contrast, for infants exposed to higher levels of CHAOS, increased maternal depression was associated with shorter average fixation durations (better attentional control). In other words, in the context of attentional control development at 3.5 months of age specifically, CHAOS appears to serve as a risk or promotive factor depending on maternal depression.

Taken together, the results of these studies suggest that the effects of CHAOS on infant development are contextually dependent and in some situations, CHAOS may have overlapping variability with positive factors such as enrichment. Results such as these should inform how researchers approach measuring CHAOS and inform theories of the effects of CHAOS early in life.

P3-F-541 - Development of navigational affordance perception in infancy

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Details

Shortly after learning to crawl or walk, toddlers successfully use vision to guide navigation through the local visual space. How does this ability develop? One hypothesis is that the emergence of navigational affordance perception depends on active navigation experience (e.g., crawling or walking). However, this hypothesis has never been tested, as almost all prior work conflates perception of navigational affordances with the integration of this information into a motor plan. Here we developed a measure of navigational affordance perception based only on preferential looking. This procedure allowed us to measure spontaneous attention to navigational affordances using the same metric, across a broad range of motor abilities from pre-crawling to walking. In 5 experiments, infants and toddlers viewed 10s videos depicting an egocentric perspective of navigation toward the corner of a room, with one wall containing an open doorway affording further navigation, and the other containing a perceptually similar distractor. We found that 16-month-old toddlers looked significantly more toward doorways (i) relative to textured, rectangular "paintings" (Experiment 1, N=33, range 14-18 months), (ii) relative to inverted doorways, strictly controlling for low-level visual features (Experiment 2, N=33), and (iii) regardless of whether the video depicted forward vs. backward ego-motion (Experiment 3, N=36). These results validate our paradigm and show that 16-month-old toddlers perceive navigational affordances as salient. Next, to test how navigational affordance perception develops, we compared the toddlers (from Experiment 1) to a younger group of pre-crawling 5-month-olds (Experiment 4, N=33), as well as a large group of 6-9-month-olds who varied in their ability to crawl (Experiment 5, N=102; including a subset of 33 age-matched pairs of crawling and pre-crawling infants). Unlike toddlers, infants in both groups looked toward whichever texture had higher contrast and spatial frequency, regardless of whether it was in a doorway or a rectangular "painting" – with no difference between crawling and pre-crawling infants. In summary, toddlers (all of whom could walk; Experiments 1-3) spontaneously look towards doorways in video displays, while infants (regardless of crawling experience; Experiments 4-5) do not. One possibility is that spontaneous attention to navigational affordances in the visual environment only arises when toddlers acquire experience navigating the environment by walking. In ongoing work, we are testing this possibility by comparing age-matched groups of walking and pre-walking toddlers on the same paradigm. Taken together, these results suggest that attention to navigational affordances develops during a period of ongoing change in active navigational experience, sometime late in infancy.

P3-F-542 - Exploring the role of high and low spatial frequencies in the development of infant selective attention to faces

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Details

Humans process faces more holistically than other stimulus types (Tanaka & Farah, 1993). The Encoding Switch Hypothesis proposes that before holistic face processing develops, infants and children up to about 10 years of age engage in a more piecemeal or parts-based perception of faces (Diamond & Carrey, 1977). However, recent research suggests holistic processing is present earlier in development than previously thought and could potentially precede parts-based processing (Nakabayashi & Liu, 2013). The current study aimed to test this alternative hypothesis. Adult behavioral data suggests that low spatial frequencies (LSF) facilitate holistic face processing whereas featural face processing relies on high spatial frequencies (HSF) (Goffaux & Roisson, 2006; Goffaux et al., 2005). Infant contrast sensitivity at LSF develops rapidly and peaks at 10 weeks of age. In contrast, sensitivity at HSF increases dramatically from 9-32 weeks of age allowing infants to perceive increasingly finer detail. This may indicate that infants initially engage in holistic processing due to the limited LSF visual information available to them. Newborns have been found to rely on LSF for face recognition (de Heering et al., 2008); however, there is a lack of research exploring the role of SF content in face perception as a function of age. The current study examined 4- (n = 11) 9- (n =10), and 13-month-old infants' (n = 11) perception and recognition of LSF and HSF filtered face stimuli. A 3x2x3 design was used with a between-subjects factor of age (4 months, 9 months, 13 months) and within-subjects factors of identity (Familiar, Novel) and SF condition (LSF, HSF, Hybrid). Filtered stimuli were created using a Fourier transformation and hard-pass spatial frequency filter to create LSF and HSF images containing only spatial frequencies below 2 cycles/° visual angle and above 6 cycles/° visual angle respectively. Hybrid image stimuli were created by combining the LSF content from one (novel or familiar) identity with HSF content from the other (Olivia & Schyns, 1999). Each trial began with a familiarization phase consisting of an unfiltered face image. Infants were then presented with paired comparison trials for novel vs. familiar faces in LSF, HSF, and inverse hybrid conditions in a preferential looking task (Fagan, 1970). Eye tracking data was collected at 500 Hz using an Eye-Link 1000 Plus (SR Research Ltd., Mississauga, Ontario, Canada). Infant visual fixation data was analyzed using a mixed effects model with fixed effects of age, spatial frequency condition and novelty in addition to a random effect of participant. There was a main effect of age ($F(2,27.9) = 9.12$, $p < .001$) and a significant interaction of age and spatial frequency ($F(4,1577.51) = 3.78$, $p = .005$). Older infants (9- and 13-month-old) fixated longer on HSF face images than 4-month-old infants. Additionally, 13-month-old infants showed preferential attention to HSF face images over LSF and hybrid images. These findings are in line with developmental trends of infant spatial frequency perception and provide potential insight into the visual information infants use during face processing.

P3-F-543 - Auditory working memory for nonlinguistic sounds at 8 months

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Details

Working memory (WM) is a limited-capacity system that temporarily stores visual and auditory information that can be used to support ongoing cognitive tasks. Historically, research on WM has been limited to adults and children who can follow instructions, limiting our understanding on WM in infancy.

Over the last two decades, however, new methodologies have allowed researchers to begin studying infant visual WM (Oakes et al., 2006, 2011, 2013; Ross-Sheehy et al., 2003, 2011), yet studies on auditory WM remain limited. Indeed, to our knowledge, there are only two studies on infant auditory WM which find that 10- to 11-month-old infants have a WM capacity for up to 2, but not 4, linguistic (Newman & Simpson, 2023) and nonlinguistic (Ross-Sheehy & Newman, 2015) items. To better understand the development of auditory WM, we tested 26 full-term 8-month-old infants using a head-turn preference procedure and a modified version of an auditory change detection task used successfully by Ross-Sheehy & Newman (2015). During the task, half of the streams were constructed of 2 instrument sequences (500ms), while the other half were constructed of 3 instrument sequences (750ms). Half of the streams were 'constant,' meaning the same 2 or 3 instrument sequences are repeated over the 20s stream. The other half of the streams were 'varying,' where one instrument changed on every sequence presentation. Broadly, we expected infants to look longer at varying than constant streams, consistent with infants' documented interest in novelty. However, we also expected this to be modulated by their auditory WM capacity such that infants with a capacity of 3 should look longer to 3-instrument varying than 2-instrument constant streams. Infants with an auditory WM capacity of 2 should look longer to 2-instrument varying than 2-instrument constant streams but should show similar looking to constant and varying 3-instrument streams as they are beyond their WM capacity. Finally, infants with a capacity of less than 2, should fail to differentiate constant versus varying streams. A 2x2 ANOVA revealed a significant effect of stream type on looking time, $F(1, 25)=4.44$, $p=0.05$, with infants looking longer on varying- than constant-stream trials. Planned pairwise comparisons revealed that while, as a group, infants looked longer at 2-instrument varying than 2-instrument constant streams, $t(25)=-2.40$, $p=0.02$, they did not differentiate 3-instrument varying from 3-instrument constant streams. However, there was considerable individual variation; 17 infants had a capacity of at least 3 items, 6 infants had a capacity of only 2 items, and 3 infants had a capacity of less than 2. Our results indicate that, like 10- to 11-month-olds, 8-month-olds already have an auditory WM capacity of at least 2 nonlinguistic items and can hold 500ms of auditory information in their WM. However, our data also suggests that a large proportion of our 8-month-olds may already have a capacity of 3 items and can hold 750ms of information in auditory WM. Implications of the development of auditory WM for theories of learning and language acquisition in infancy will be discussed.

P3-F-544 - Visual context modulates the categorization of facelike visual stimuli in the young infant brain

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Details

Face pareidolia is the illusory perception of a face in ambiguous objects or patterns (e.g., clouds depicting a face shape; Wardle et al., 2020), as reflected by face-selective electroencephalographic (EEG) activity in both adults (Rekow et al., 2022a) and infants (Rekow et al., 2021). However, the perceptual interpretation of these facelike stimuli depends on the context in which they are presented (Rekow et al., 2022b; Bourgaux et al., in prep). Indeed, we recently developed a paradigm using a frequency-tagging approach – which allows for short and efficient recordings, has an excellent signal-to-noise ratio

and is immune to most artifacts (Kabdebon et al., 2022; de Heering & Rossion, 2015) – to address this issue (Bourgaux et al., in prep) and we found that, in adults, face-like stimuli are more interpreted as faces in a non-face context and as non-face objects in a face context. Accordingly, here, we aim to explore how visual context shapes the perception of these facelike stimuli early in life. We thus measured scalp EEG activity in 4-to-6 months-old infants who were exposed to 20-second stimulation sequences of natural images presented at a rate of 6 images per second (6 Hz), with facelike items inserted every 5th image (at 1.2 Hz), and face or house items inserted every 4th image (at 1.5 Hz) in dedicated sequences, defining a visual face or non-face context, respectively. Preliminary data (N = 10 infants) reveal that the brain response to facelike stimuli is present in the young infant brain although weaker in amplitude than in adults. In addition, contrary to the adult responses, the infant response is also more face-like in the face context (with a typical occipito-temporal location of the response, as in Rekow et al., 2021) and shifts to a more occipital response in the non-face context. While these preliminary results still need to be consolidated (recruitment is ongoing), they suggest that the influence of visual context on the categorization of ambiguous, facelike stimuli changes throughout development, likely due to the effectiveness of perception at a given developmental stage.

P3-F-545 - The association between caregiver and infant executive functions

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Details

Objective: Caregiver executive functions play an integral role in shaping cognitive and socio-emotional function in children. Most research has focussed on understanding this association in toddlerhood or early childhood. Thus, it is unclear whether caregiver cognitive behaviours influence neurocognitive development as early as the first year of life. In the current study, we investigated whether caregiver executive functions are associated with infant executive functions. Further, we inquired whether this association is moderated by contextual factors such caregiving- and household-related stressors and socioeconomic status.

Methods: 80 infants (*Mage* = 287.80 days, *SD* = 15.17), (Female=45) and 88 caregivers (*Mage=33.47, SD 4.48)*participated in the study. Caregivers completed the behaviour rating inventory of executive function - adult version (BRIEF-A) questionnaire to provide information on executive function and regulation, the Early Executive Functions Questionnaire (EEFQ) to provide information on their infants' executive functions, the Parental Stress Index Questionnaire to provide information on caregiver related stressors and caregiver life stress outside the scope of caregiving and a socioeconomic status (SES) questionnaire to provide information on household income and caregiver/partner educational attainment. Correlational analyses were run to investigate the association between caregiver and infant executive functions. Further, moderation analyses were run to assess the impact of caregiving- and life-related stressors and SES on this association.

Results: Exploratory factor analysis on the BRIEF-A data revealed a two factorial structure composed of organization and regulation (planning, organization, initiation, working memory, task monitoring, shifting and emotional control), and response monitoring (inhibition and self-monitoring). Exploratory factor

analysis of the EEFQ data revealed a four-factorial structure composed of items making up distractibility (for e.g., seem to forget what they were doing, mid-way through), sustained attention (for e.g., work for a long time trying to do something tricky), response inhibition (for e.g., hesitate for at least a second when you said "no / don't touch" or similar) and emotional inhibition (for e.g., quieten down when you 'shushed' them so as not to disturb others). We found that poorer caregiver organization and regulation was associated with greater distractibility and poorer emotional inhibition in infants. Caregiving-related stress and caregiver life stress moderated these associations. Socioeconomic status did not moderate any association. Finally, there was no association observed between caregiver response monitoring and infant executive functions.

Conclusion: Our findings contribute to the understanding of an under-explored area of research focussed on understanding the association between caregiver executive functions and infant executive functions.

P3-F-546 - Infant selective attention and intersensory processing of audiovisual speech

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Details

Intersensory redundancy (IR) refers to simultaneous and synchronous presentation of amodal information across two or more sensory modalities. Previous research indicates IR facilitates detection of amodal information in audiovisual speech events (e.g., affect, Flom & Bahrick 2007; prosody, Bahrick, McNew, Pruden, Castellanos, 2019) at the expense of modality-specific information (e.g., facial characteristics; Bahrick, Lickliter, Castellanos, 2013). Bahrick and Lickliter (2000, 2002, 2014) propose this intersensory facilitation is based on IR directing infant selective attention to amodal properties over modality-specific properties of multimodal events. However, no study to date has examined infants' ability to detect changes in both amodal and modality-specific stimulus properties conveyed within the same event. To address this gap, we measured event-related potential (ERP) correlates of attention and recognition memory while infants were tested with synchronous audiovisual or asynchronous audiovisual speech. High-density EEG was measured while 5-month-old infants (N=34) were tested in a synchronous or an asynchronous condition. Infants in the synchronous condition, which provided IR, were shown video clips with temporally aligned audio and video tracks. Infants in the asynchronous condition, which did not provide IR, were shown video clips with temporally misaligned audio and video tracks. The procedure for both conditions began with a training phase followed by a testing phase. In the training phase, infants received 20 brief (1700ms) presentations of a video clip of a woman reciting a phrase conveying either positive or negative affect. In the testing phase, infants were shown three different stimulus types, familiar (familiar actress, same affect as during training), novel-affect (familiar actress, opposite affect as during training), or novel-face (novel actress, same affect as during training). No differences were found in amplitude of the Nc component associated with magnitude of attentional engagement (Richards, 2003) indicating infants were equally attentive to each stimulus type and across synchronous and asynchronous presentation conditions. Our analysis of the late slow (LSW) ERP

component associated with infant recognition memory (de Haan & Nelson, 1999), revealed significant differences between groups. At temporal electrodes, infants in both the synchronous and asynchronous conditions demonstrated significant differences in LSW amplitude between novel-face trials and familiar trials ($t(34)$ 2.34, p = .03) indicating infants discriminated the familiar face from the novel face regardless of presentation condition. In contrast, at frontal electrodes, only infants provided IR in the synchronous condition showed significant differences in the amplitude of the LSW in novel-affect compared to familiar trials ($t(11)$ = 2.72, p = .02). No differences based on stimulus type were found at frontal electrodes for infants tested in the asynchronous condition (ps > .50). These findings converge with behavioral studies and indicate that IR can facilitate 5-month-old infants' processing of amodal information (i.e., affect) provided by audiovisual speech. Although further research is needed, these results also indicate intersensory facilitation of recognition memory for amodal properties of audiovisual speech may be associated with recruitment of anterior cortical regions.

P3-F-547 - The formation of novel scene categories in 14-month-old infants

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Details

Infants' formation of object categories is well documented across the first years of life (Mareschal & Quinn, 2001; Rakison & Yermolayeva, 2010), but it remains an open question when infants begin to learn more complex, abstract categories such as scenes (e.g. "beach", "bedroom"), which require integrating information beyond individual objects (Malcolm et al., 2014, 2016). Just like for objects there may be "diagnostic" features such as water at a beach, or a bathtub in a bathroom. Inconsistent objects in familiar scenes are detected by 24-month-olds (Maffongelli et al., 2020), but to learn new scene categories, attention must be directed at more than a single feature (e.g. understanding that tiled walls are as much a part of "bathroom" as the sink and tub), and referential cues may be more ambiguous or rare (e.g. pointing at "bathroom" is hard while inside). Heuristics commonly discussed with regard to word learning, e.g. the whole object constraint or shape bias, are therefore less useful for learning scene categories.

We used a familiarization/novelty preference procedure to investigate whether 14-month-olds (N=26 , mean age=432 days , 12 girls) can learn a novel scene category. A set of stimuli was constructed that each showed the drawing of a room containing three constituent objects (one from each of three categories, see Figure 1), which were placed in pseudo-randomised spatial configurations. The three categories were constructed to contain items of high (2 categories) vs. low (1 category) variability. Each image showed an exemplar of a room category that contains a highly diagnostic item (like a sink in a bathroom) and two more variable items (like an armchair or couch in a living room). After a familiarization phase (8 images, 6 s each, with a labelling phrase, e.g. "Look, it's a folarium!"), infants were presented with 4 test trials that featured one previously unseen image from the familiarized category paired with an out-of-category item such that (1) the low-variability item was replaced by a novel object, (2) one of the high-variability items was replaced by a novel object, (3) all three objects were replaced by novel objects, (4) the background was replaced.
Eye tracking results (Figure 2) indicate that infants encoded some, but not all, aspects of the scene

category (one-way anova: $F(3,96)=3.54$, $p=.018$). We observed a systematic familiarity preference when the low-variability object was replaced (novelty preference score: $M=.42$, $SE=.04$, $t(23)=2.19$, $p=.04$), no preference when a high-variability object was replaced ($M=.5$, $SE=.05$, $t(24)=.05$, $p>.95$) or when all objects were replaced ($M=.41$, SE=.06, $t(24)=1.55$, $p=.13$), and a significant novelty preference when the background was replaced ($M=.60$, $SE=.05$, $t(25)=2.15$, $p=.04$).
The fact that infants notice when the two most consistent aspects, low-variability object and background, are exchanged indicates successful category encoding, but their familiarity preference indicates that task complexity is very high, and the lack of preference on the remaining test trials shows that the category representation is not detailed at this point.
We will discuss these results as well as area-of-interest-based analyses and data from 17-month-olds (data collection ongoing).

P3-F-548 - Perceptual primitives of aesthetics are revealed by infants' visual preferences for art, building facades, and abstract patterns

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Details

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The question of why humans find certain things such as faces, objects, and art beautiful and aesthetically pleasing attracts a large multidisciplinary field of research. However, there has been little consideration of how aesthetic judgements develop. One theory is that aesthetic judgements emerge, in part, from early sensory biases for low-level chromatic and spatial image properties ('perceptual primitives'). Consistent with this, several studies have found that infants look longer at the faces and colors that adults like (e.g., Skelton & Franklin, 2020). Here, we investigate whether there is a relationship between infant looking and adult liking for other types of stimuli, and investigate whether certain chromatic and spatial image properties predict both infants' and adults' responses.

We present 3 studies that measure infants' visual preferences (as measured by looking time) and adults' aesthetic judgements for van Gogh landscapes (study 1; Figure 1a), building façades (study 2; Figure 1b), and achromatic statistical fractal patterns (study 3; Figure 1c). Infant looking was recorded remotely via Zoom with a colour-calibrated iPad in study 1, and with an eye-tracker in studies 2 & 3 (total N=75 infants, 120 adults). Partial least squares regressions were conducted in study 1 to establish if a set of chromatic and spatial image statistics predict infants' and adults' response. Study 2 analyzed the contribution of edge statistics – in particular the entropy (randomness) of the edge orientations, and study 3 analysed the contribution of fractal dimension (the extent to which patterns repeat at different scales).

We find similarity between infants' visual preferences and adults' aesthetic judgements: infants generally looked longer at the stimuli that adults like. The variance shared between infant looking times and adult aesthetic judgements ranged from 13% (study 1; Van Gogh landscapes) to 61% (study 2; building façades). A model of chromatic and spatial image statistics was strongly predictive of infants' visual preferences and adults' aesthetic judgements for Van Gogh landscapes. The amount of luminance and chromatic contrast in the artworks were important to both infants' visual preference and adults' aesthetic judgement. The entropy of oriented edges was also highly predictive of both infants' and adults' response to building façades: infants looked longer and adults preferred ornate facades where edge orientations were varied and certain orientations did not dominate. Finally, fractal dimension was related to both infant looking time and adult aesthetic judgements.

The remarkable similarity of infants' visual preferences and adult's aesthetic judgements for some types of stimuli provides support for the theory that some aesthetic judgements can be partially traced back to early sensory biases in infancy. Certain image statistics such as high luminance and chromatic contrast, edge orientation entropy, and fractal dimension are good candidates for 'perceptual primitives' of aesthetics. Such sensory biases may result from the visual system being tuned to the chromatic and spatial statistics of natural scenes. The findings provide new insight into the role of image statistics in infant vision and scene perception, and illustrate how even young infants' visual systems are able to extract chromatic and spatial image statistics from complex images.

P3-F-549 - Dynamics of caregiver unpredictability direct moment-to-moment shifts in infant attention

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Details

Early cognitive development is related to how predictable an infant's caregiver is (Davis et al., 2017), but the mechanism driving this relationship is unknown. One possibility is that caregiver predictability offers infants an opportunity to *learn to attend* to readily available sources of information that hold predictive value. In that case, caregiver predictability would need to 1) vary from context-to-context and 2) capture infant attention in a manner that allows infants to learn to attend to the most predictive signal in each context.

To test this, we recorded naturalistic dyadic interactions between 2-6-month-old infants and their caregivers (N=222), in two contexts (with and without toys present). Then, we hand-annotated infant attention (looking at caregiver) and five caregiver behaviors frame-by-frame, and measured how

unpredictable caregivers were by calculating the entropy (Shannon, 1948) in their likelihood of transitioning from one behavior to another. We measured this unpredictability following each behavior, and as an overall average across behaviors to examine how caregiver unpredictability differs as a function of toy-context. We found that overall maternal entropy did not vary by context (M_{Toy} = 0.94, M_{NoToy}= 0.89, $t(221) = 1.77$, $p = 0.08$, *Cohen's d* = 0.14). However, the particular behaviors which were more or less unpredictable did vary, such that caregiver unpredictability following vocalizations was higher without a toy present (M_{Toy} = 0.59, M_{NoToy}= 0.77, $t(114) = -2.70$, $p < 0.01$, *Cohen's d* = -0.34), while unpredictability following object holding was higher with a toy present (M_{Toy} = 0.87, M_{NoToy}= 0.61, $t(96) = 4.44$, $p < 0.001$, *Cohen's d* = 0.60). Infant looking was negatively related to caregiver overall entropy, but driven by unpredictability in the most informative signal in each context (i.e. infant looking related to caregiver vocalization unpredictability when no toys were present, $r = -0.18$, but related to unpredictability following caregiver object holding when toys were present, $r = -0.32$, *Figure 1*). We also divided the dyadic interaction recording into 20-second windows, and computed overall caregiver entropy and infant attention within each window. We then modeled infant looking as a function of their own caregivers' entropy in each window, and found a significant quadratic relationship between caregiver entropy and infant looking (effect of quadratic term, $t = -3.02$, $p < 0.01$, *Figure 2*), such that infant looking was highest when caregivers were slightly more predictable than their own average.

Thus, by asking caregivers to play with their infants, with and without toys, and measuring their predictability across domains, we provide two pieces of evidence in support of the hypothesis that caregiver predictability shapes cognitive development via shaping infant attention. First, the structure of caregiver behavior is shaped by environmental affordances, and infants' looking behavior is related to the most informative caregiver signal. Second, we demonstrate an attentional 'goldilocks' effect in a naturalistic environment, whereby infant looking to their own caregiver is highest when she is neither highly predictable nor highly unpredictable. This demonstrates that context-to-context and moment-to-moment fluctuations in regular environmental input shape infant looking and learning.

P3-F-550 - At home engagement: How mothers encourage joint attention with their infants in naturalistic settings

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Details

Joint attention has been widely studied as a foundational component of early social, communicative, and cognitive development. Infants demonstrate rapid development in coordination of joint attention skills between 12 and 18 months of age. Social partners influence and scaffold a child's attention to engage in joint interactions through attention-directing strategies. Previous literature has examined these attention-directing strategies widely in standardized settings, often with a structured set of toys for infants and their partners to engage with (Mendive et al., 2013). Until now, few studies have investigated how maternal attention-directing behaviors operate on an infant's attention during naturalistic interactions within the home setting.

The purpose of this study is to examine temporal relations between maternal attention-directing and infant engagement states in both natural play and structured play conditions within the home environment. This study will address the following research questions: (1) How do variations in maternal attention-directing strategies affect the duration of joint attention? (2) Which maternal attention-directing strategies lead to more complex forms of attention? (3) How does the effect of maternal attention-directing on infant attention differ in structured play versus natural play? (4) How do maternal attention-directing and infant attention change over the course of the second year of life (12-24 months old)? (5) How do infant engagement states differ between natural play and structured play?

Method: Behavioral coding is being conducted on home visit videos obtained by the Play and Learning Across a Year (PLAY) Project. The sample includes 31 mother-infant dyads: 11 12-month-olds, 10 18-month-olds, and 10 24-month-olds and their mothers. Dyads completed a multi-part home visit, including a one-hour natural interaction, a 5-minute structured play, as well as various questionnaires.

Planned Coding and Analyses: Utilizing a five-minute video portion of a one-hour natural in-home interaction and a five-minute structured play session, we coded for infant engagement states (IES; Bakeman & Adamson, 1984; Mendive et al., 2013) and maternal attention-directing strategies (ADS; Landry et al., 1989; Mendive et al., 2013). All coding procedures, hypotheses, and analyses are preregistered at https://aspredicted.org/blind.php?x=PDC_BMN. Sequential analysis will be performed to investigate dynamic and time-dependent relationships between maternal attention-directing strategies and infant engagement states. This analysis will enable us to identify whether specific strategies used by mothers are more likely to result in particular infant engagement states and whether there is temporal structure in the sequences. In addition, we will be using descriptive statistics to compute relative proportions for each engagement state and attention-directing strategy in both conditions. By examining the impact of attention-directing strategies on infant attention and the differences in these interactions between natural and structured play, our research can contribute valuable insights to the understanding of early social and cognitive development during the second year of an infant's life. The findings from this study have the potential to enhance our knowledge of the nuanced social interactions shaping infant attention and engagement in real-life, naturalistic contexts.

P3-F-551 - Relations among infant attention-following and language development, and caregiver's infant-directed speech, from 4 to 22 months

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Details

Joint attention (JA), which occurs when caregivers and infants coordinate their attention to the same object, is believed to contribute to early language learning. However, previous research on associations between early infant attention-following (AF) and later language development has yielded mixed results. Several studies have found positive correlations between early AF tendencies and infant vocabulary (e.g., Tomasello & Farrar, 1986), suggesting that, for example, JA episodes can build infants' vocabulary, and/or that more socially oriented infants engage in more AF and attend more to caregivers' speech.

However, other studies have reported inconclusive associations between infant AF and later language (Markus et al., 2000; Zampini et al, 2015).

These mixed findings could be due to interrelated variables such as caregiver's Infant Directed Speech (IDS) during attention-sharing interactions. Parents often use vocalizations to capture infants' attention during JA episodes (Tang et al., 2023). Moreover, Tamis-LeMonda et al. (2013) demonstrated an association between infants' attention status and mothers' object-naming utterances during dyadic toy play, and Chang et al. (2016) found more maternal utterances with object names while infants attended to objects. Such findings suggest that IDS could be a mediating factor during JA. Notably, many studies have established that the *lexical quantity* and *diversity* of caregivers' IDS predicts infant language outcomes (e.g., Jones & Rowland, 2017). To better understand how these factors mediate the relationship between infants' AF skills and later language development, we followed AF development in infants (*N*=43) monthly from 4 to 12 months. To assess JA development, we gave infants a scripted AF task monthly in a laboratory setting. Experimenters used gaze, point, or gaze-and-point cues in discrete trials to indicate one of several target monitors (see Tang et al., 2023). Infants' looking responses were coded. To sample maternal speech, infant-mother dyads were video-recorded at home monthly in free play and attention-directing interactions. Maternal speech was transcribed, and behaviors indicating mothers' and infants' attention (e.g., gaze, manual activity) were coded (see Table 1).

Results showed significant correlations between infants' 9-12 month AF skills (pooled) and their receptive and expressive language scores (see Figure 1) at 12 months; however, the associations for later language measures were weaker and more variable. We also are analyzing how caregiver IDS input from 4 to 9 months, quantified as maternal word tokens and types, predicts infant language separately or in interaction with infant AF from 4 to 9 months (Table 1), even when controlling for maternal education (Pace et al., 2017). Early analyses show that caregivers exhibit varying but stable amounts of IDS at home during toy play and JA episodes. Ongoing analyses are exploring how specific IDS metrics (e.g., lexical diversity; utterance content: Chang et al., 2018) correlate with infant AF and language development, and how the three variables are interrelated.

This study offers insights into the relationship between AF skills, caregiver IDS, and infant language development from 4 to 22 months. The findings may inform early assessment and intervention approaches toward communication development in children with developmental disorders.

P3-F-552 - Exploring the role of overt visual attention in toddlers' understanding of third-party joint attention

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Details

To investigate whether infants recognize interpersonal sharedness in episodes of joint attention, previous studies have traditionally relied on infants' overt visual attention markers. The sequence of an infant's looking at an adult partner, then looking at an object, and then looking back at their partner has often been interpreted as an indicator of infants' awareness of the mutuality of the shared object look (e.g. Bakeman & Adamson, 1984; Carpenter & Liebal, 2011). In this study, we want to explore whether similar indicators exist when children merely observe others' joint attention: Can toddlers' gaze behavior reveal markers of their third-party triadic sharedness recognition, and, if so, what are they?
To address this question, we plan to include N = 36 German 36-month-olds. Participants will see multiple trials of a screen-based eye-tracking task. Each trial consists of two phases: a sharedness induction phase and a test phase. In the sharedness induction phase, children see videos introducing two actors, one of them holding an opaque bag. The key manipulation is the degree of joint engagement between the actors, resulting in three conditions: joint attention, parallel attention, and control. The manipulation is implemented visually and verbally (Table 1). In the joint attention condition, the two actors stand face-to-face, and participants are told that in the next scene (i.e. test phase), the actors will unpack a toy from the bag and look at it together. In the parallel attention condition, two actors stand back-to-back, and participants are told that the actors will be looking at the toy each on their own. In the control condition, the two actors face forward while looking down, and participants are told that they are about to see the actors and the toy.
In the test phase, children see a still image showing the two actors again, but this time the toy from the bag is visible. One of the actors is holding the toy and both actors are looking at it (Figure 1). Crucially, the scenes are conceptually identical across conditions, and the interpersonal jointness is ambiguous. This allows us to explore whether children's representation of jointness or non-jointness (as induced in the previous phase) leads to a specific attention pattern. As the dependent measure, we will extract distinct gaze patterns in the test phase using a data-driven n-gram-based approach, and compare them across conditions using Bayesian modeling. If any of the extracted scanning patterns uniquely and reliably characterize the joint attention condition, and not any of the other two conditions, such patterns will be interpreted as overt attentional markers of inferring sharedness. Studying such markers entails the potential of providing a direct window into how individuals perceive and understand third-party joint attention. This offers a promising avenue for studying the ontogenic and phylogenetic development of joint attention, by applying the approach with younger infants and in comparative studies with non-human primates.
We have finished piloting and plan to start data collection soon. We expect to finish collecting and analyzing data by early July. The study is preregistered at
https://osf.io/8hf45/?view_only=758b76564a92422d8774c444de8dff75

P3-F-553 - Lateralization in gaze when viewing social and non-social stimuli: Insights from a study of 5-month-old twins

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Details

Background. Looking at the face of others is an important aspect of social communication, since it can give us information about the intentions, emotional states, and familiarity of others. When viewing faces, humans have a well-known tendency to preferentially look at the left side of the face from the observers' point of view. This left gaze bias has been extensively studied in adults (e.g., Burt & Perrett, 1997; Butler et al., 2005; Guo, Smith, Powell, & Nicholls, 2012) and has been hypothesized to be a tendency based on a right hemisphere advantage in social perception and face processing (Harrison & Strother, 2021). However, it is not known whether this face-specific left gaze bias develops from a more general left gaze bias, and whether genetic factors influence individual differences in this measure. **Objectives**. To study gaze lateralization in early infancy using eye tracking. The goal of this study was twofold: 1) to estimate gaze lateralization during face observation and 2) to more broadly estimate lateralization tendencies across a wider set of social and non-social stimuli. An additional goal was to estimate the influence of genes and environment on individual differences in gaze lateralization. **Methods.** The sample consisted of 592 twins (282 females, 330 monozygotic twins). At 5 months of age, we recorded their gaze while viewing faces and two other stimuli consisting of either collections of dots or static faces interspersed with non-social objects (Figure 1). Concurrent general development was estimated by an experimenter, and parent-rated questionnaires on language, socio-communicative abilities, and autistic traits were collected at 14 and 36 months. **Results.** A statistically significant right gaze bias (i.e., different from chance level, 0.5) was found when viewing faces (mean = .390, t(551) = -11.63, p <.001, Cohen's d = -0.50), and individual differences in this measure was influenced by genetics (A = .38, 95% CI: .24; .50). When viewing non-social stimuli, a significant left gaze bias was observed (mean = .554, t(513) = 68.08, p <.001, Cohen's d = 3.00), while a significant right gaze bias was found when viewing faces interspersed with objects (mean = .472, t(558) = -4.57, p <.001, Cohen's d = -0.19). No genetic influence was found on gaze lateralization in these conditions. While gaze lateralization when viewing non-social stimuli showed a small influence of shared environment, gaze lateralization when viewing faces and objects interspersed was only influenced by unique environmental factors. No associations were found between gaze lateralization and concurrent or later traits. **Conclusions.** These results suggest that there is no general left gaze bias at 5 months of age. While the infants tended to look at the left side of the screen when viewing non-social stimuli, a bias to the right was found when viewing stimuli that included human faces. Genetic influence on individual differences in gaze lateralization was only found for the tendency to look at the right versus left side of faces, suggesting genetic specificity of lateralized gaze when viewing faces.

P3-F-554 - The influence of face-voice gender congruence on infants' face recognition

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Details

Social categories are crucial for functioning in our society and gender is one of the main dimensions of categorisation. Infants categorise faces and voices by gender before 12 months , and after 12 months they begin to associate faces and voices by gender (Poulin-Dubois et al., 1994, 1998). While we know that in adults and children face-voice congruence can affect recognition and memory processes, we do not know when these abilities emerge. So this study examines whether face-voice

gender congruence modulates infants' face recognition. We chose female faces because infants are more familiar with them (Ramsey- Rennels, Langlois, 2006; Quinn et al., 2002).

We tested 115 infants from three age groups: 12-months-olds (N=33), 18-months-olds (N=43) and 24-months-olds (N=39). Participants first saw a familiarisation video of a female face singing a French nursery rhyme. The singing voice was either gender-congruent (female voice) or gender incongruent (male voice) with regards to the face presented. Immediately after, for the test trial phase, children were exposed to two 5-second long test trials presenting the familiar face, alongside a novel face (figure 1). We video-recorded infant looking behaviour and analysed their gaze offline. We calculated the Total Looking Time (TLT) during familiarisation and the Percentage of Total Looking Time (PTLT) to the familiar face during test trial.

First, for the familiarisation, only the 24-months-olds looked longer at the incongruent condition ($p=0.028$). All other age groups looked equally long at the gender congruent and incongruent conditions ($p >0.195$). Furthermore, during the test trial phase, we found that 18-month-olds looked longer at the familiar face compared to chance level ($p=0.040$), but not their younger and older counterparts. If we compare PTLT to the familiar face against chance level for each congruence condition and age groups, none of them perform above chance ($p>0.112$). For the 24-month-olds we found an effect of test trial order. They displayed a significant preference for the familiar face during the first trial ($p=0.007$), and a switch to a preference for the novel face during the second trial ($p=0.036$). Finally, an Anova found no significant effect of age or congruence on the PTLT (figure 2).

First, our results from the familiarisation phase suggest that infants become sensitive to face-voice gender congruence around 24 months. This is in line with previous studies that used static stimuli and showed that this face-voice gender incongruence is noticed even at 18 months. (Poulin-Dubois et al., 1994,1998). Second, infants failed to recognise the familiar face, under both congruence conditions, even at 24 months of age. One possible explanation is that dynamic stimuli are more difficult to process and recognise for infants.

We are currently conducting a follow-up study using static faces in the familiarisation phase to confirm if video stimuli interfere with face recognition processes. This study will also be included in this presentation.

P3-F-555 - The impact of COVID-19 pandemic on face scanning

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Details

Faces play a crucial role in the environment of human infants, with face scanning often being multimodal, accompanied by concurrent sounds. In the first year of life a specific face scanning trajectory has been found when infants are presented with audiovisual speech (Lewkowicz & Hansen-Tift, 2012; for a review

on dynamic face perception see Bastianello et al., 2022). Ayneto & Sebastian-Galles (2017) investigated whether this developmental shift is domain-general or only language specific. They tested 8- and 12-month-olds using audiovisual stimuli expressing different emotions (laughing, crying, neutral). Results indicated that at 8 months, bilingual infants focused more to the mouth than their monolingual peers in all conditions (Experiment 2), while at 12 months no differences were observed, i.e. monolingual and bilingual infants looked similarly to the eye and the mouth area. The authors entertained the hypothesis that these results coincide with the developmental path found in audiovisual speech processing (Pons et al., 2015). The potential impact of the COVID-19 pandemic on infants, who had limited access to facial cues due to the use of masks, remains understudied. Our objective is twofold: to extend previous findings by testing a new age group, hypothesizing that monolingual and bilingual infants would exhibit similar attention patterns and to conduct a cross-sectional comparison between pre- and during-pandemic participants. Our preliminary findings suggest that monolingual and bilingual infants show similar gaze patterns at 4 months, focusing predominantly on the eye area. However, a difference was found between the pre- and during- pandemic sample. Infants born during the pandemic seem to spend a significant amount of time looking at the mouth area in the laughing condition compared to the pre-pandemic sample. Our results enhance our understanding of the developmental trajectory of face scanning during the first year of life, highlighting that the use of face masks or reduced facial diversity may render the mouth area more salient, inducing an earlier shift to the mouth area even for non-linguistic stimuli.

P3-F-556 - Neural correlates of self-recognition in 6- to 8- month-old infants

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Details

Objective: Self-recognition, i.e. the ability to identify one's own facial features as being part of the self, is thought to develop with the emergence of overt self-directed behaviours, e.g. embarrassment in front of a mirror at around 24 months (Rochat, 2009). However, infants' looking behaviour studies suggest that infants show a visual preference for other- vs self-face well before displaying overt behaviours in front of reflective surfaces (e.g. Bahrick, Moss & Fadil, 1996), suggesting a familiarity effect to the self. Yet, one's own face is not just familiar. The self-face holds a special status in the way we may distinguish it from others, and recognise it, as our own. I will present the results of a registered report that aimed to disentangle the role of familiarity and own-face specificity for self-recognition by examining ERP responses in two different samples of 6-to-8-month-old infants.

Methods: Over two distinct experiments, we presented infants with images of their face, another peer's face, and their mother's face (N=38, Exp.1); and images of their own face morphed into another peer's face (N=38, Exp.2). For both experiments, brain electrical activity was recorded via Hydrocel Geodesic Sensor Net (Electrical Geodesic Inc.), consisting of 128 electrodes evenly distributed across the scalp and referenced to the vertex. We examined neural responses at both N290 and P400 given previous results from Stapel et al. (2017), as well as the suggestion from the literature that the adult N170 face-sensitive component emerges due to the integration of these two distinct components (Halit et al., 2003). To examine effects of familiarity, we also tested whether differences between self- and other-faces are present in the infant Nc.

Results: Contrary to our preregistered hypotheses, we didn't find a significant difference in ERPs amplitude over the N290/ P400, and Nc components in neither experiments. However, exploratory analyses of Experiment 1 revelead a significant difference between the self-face and the mother-face condition 100ms after stimulus onset, with a larger P100 amplitude for self-face than mother-face. Hemisphere analysis also revealed a larger P100 amplitude for self-face compared to both mother-face and other-face, which were localised on the left hemisphere (see Figure 1).

Conclusions: Our results suggest that around 7 months, infants can discriminate their own face from other familiar and unfamiliar faces, already 100 ms from stimulus onset. This attentional response could indicate that one's own face requires specific attentional resources at an initial phase compared to other faces. We suggest that P100 modulation for the self-face might represent a precursor of the behavioural advantage in self-identification observed in adults.

P3-F-557 - Exploring the infant schema in the auditory domain: a comparative study between mothers and non-mothers

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Details

The concept of the infant schema, a set of infantile features that evoke caregiving and affection, has been extensively explored in visual domains. However, its manifestation in the auditory domain remains under-researched. This study aims to bridge this gap by investigating how both mothers and non-mothers implicitly and explicitly respond to infantile vocalizations compared to those of adults, cats, and kittens.
Our participants comprised 21 females without children and 21 mothers of infants aged between 4 and 7 months. We employed a single-category implicit association task (IAT) alongside a detailed questionnaire to delve into this phenomenon. The IAT involved four synthesized vowel sounds (infant, adult, cat, kitten), and required participants to categorize sounds into their own category and written words as positive or negative. In one block the name of the sound is paired with the word "Positive" on the same side, and in the next, it is paired with the word "Negative". For the IAT, we employ the D-score, a statistical measure that is calculated by evaluating the differences in response times between the positive and negative pairings in the test, offering an objective metric for assessing the strength and direction of subconscious associations in individuals.
The questionnaire assessed participants' preferences and perceptions on a 0 to 100 scale, probing how much they liked babies, adults, cats, and kittens, along with how cute they found these entities and the sounds they produced. This approach enabled a comprehensive understanding of both implicit and explicit attitudes towards these different sound sources.
Our findings revealed that in the IAT both groups exhibited a positive implicit association exclusively towards baby vocalizations, with no such association for adult, cat, or kitten sounds. The results demonstrated considerable significance for non-mothers (mean D-score = 0.188, $p = 0.00057$) and for mothers (mean D-score = 0.206, $p = 0.0159$). Interestingly, there was no significant difference in positive associations between mothers and non-mothers (p-value = 0.8343), suggesting a universal implicit affinity towards infant sounds.

However, the outcomes of the questionnaire conveyed different insights. Mothers demonstrated significantly higher explicit preferences for babies. They rated their liking for babies ($p = 0.004347$), the cuteness of babies ($p = 0.02756$), and the cuteness of baby vocalizations ($p = 0.01241$) much higher than non-mothers did. These differences were not observed in attitudes towards adults, cats, or kittens, highlighting a distinctive maternal bias in explicit preferences.
The study reveals a complex interplay between implicit and explicit responses to infant sounds. Mothers and non-mothers implicitly favor baby vocalizations, but only mothers show stronger explicit preferences. This distinction suggests motherhood intensifies explicit preferences for infants, although the implicit affinity for infantile vocalizations seems more universal. This research contributes to advancing the understanding of the auditory aspects of the infant schema and the nuanced differences in maternal versus non-maternal responses to infantile cues.

P3-F-558 - Maternal audio-visual correlation influences social preferences in bobwhite quail chicks (Colinus virginianus)

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Details

Research with non-human animal neonates as well as human infants has documented the salience of intersensory redundancy (the same amodal information such as tempo, rhythm, or duration temporally synchronized across two or more senses) in promoting infant selective attention, learning, and memory (reviewed in Bahrick & Lickliter, 2012). Given the importance of intersensory redundancy to infant selective attention and perceptual learning, we were interested in whether and to what extent redundant social stimuli such as movement and vocalizations could contribute to the development of early social preferences. Because manipulating sensory experience during early development is necessarily constrained for human participants, animal models can more readily explore perceptual factors influencing early social development. Precocial birds such as quail provide a useful model for such work, as chicks hatch with functioning sensory and motor systems and can responds in behavioral tests within hours following hatching. Our prior research with quail chicks has shown that when neonates are presented with two robotic maternal hen models, one of whose head movement and maternal vocalizations occur in temporal synchrony and the other whose head movement and vocalizations are asynchronous, they prefer the synchronous hen and avoid the asynchronous hen. In the current study, we again utilized two robotic quail hens to simulate maternal behavior to further assess quail chicks' responsiveness to patterns of maternal movement and vocalizations in the days following hatching. Using remote controlled robotic hens allows for highly controlled and repeatable social choice tests across different trials and ages. As in our previous study, maternally naïve quail chicks were presented with two robotic hens in simultaneous choice tests at 48, 72, or 96 hr. following hatching. In these test trials, individual chicks were presented with both positively and negatively correlated maternal movement and vocalizations. Positive correlation was defined as timing the robotic hen's vocalization of the maternal call with her head being in an upright position; negative correlation was defined as timing the hen's vocalizations when the hen's head was facing down. Social preference was determined by the total amount of time spent in proximity to each hen model (positive or negative correlation) during a 5-minute test trial. Results indicated that

quail chicks showed a significant preference for the positively correlated robotic hen over the negatively correlated hen across all ages tested. Importantly, chicks showed no preference for either robotic hen when the correlation presented (positive or negative) was identical across both robotic hens during test trials. This robust preference for positive correlation between maternal head position and vocalizations highlights the perceptual sensitivity of quail chicks in the days following hatching and suggests that in addition to intersensory redundancy, other nuanced features of audio-visual stimulation can play a role in the development of early social preferences.

P3-F-559 - Bilingual exposure supports own- and other-race face recognition in 9-month-old infants raised in a multi-ethnic city

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Details

The other-race effect (ORE) describes the fact that we are more susceptible to recognition errors for faces from an unfamiliar racial group and it develops as early as the first year of life: Whereas 3-month-old infants can still discriminate among identities of different racial groups, this ability narrows in the following months. By 9 months, infants robustly fail to discriminate faces unless they belong to their most familiar racial group (Kelly et al., 2007; Sugden & Marquis, 2017). While the ORE's developmental time course is well understood in infants with predominant exposure to a single-race face category and a single native language (monolinguals), we do not currently know how more diverse face and language exposure (bilingualism) shape own- and other-race face perception. Research points to increased sensitivity to faces (Mercure et al., 2018; Mousley et al., 2023) as well as differential distribution of selective attention to moving faces in bilingual compared to monolingual infants (Pons et al., 2015). The city of London offers a rare setting to study infant populations who grow up with exposure to people from a multitude of linguistic and ethnic backgrounds in their early lives.

We tested 9-month-old monolingual (mean exposure to L1=98%) and bilingual (mean exposure to L2= 29%) predominantly Caucasian infants from the greater London area on a face recognition task with own- and other-race, dynamically moving, silent faces. In addition to recognition ability, we measured selective attention to facial features during habituation and test. Detailed information on infants' face and language exposure were gathered from caregivers to quantify infants' lived experience with linguistic and racial diversity. The monolingual and bilingual groups were matched on age and did not differ on several socio-economic variables (average level of education attained by mothers, average level of education attained by fathers, average household income). While face exposure scores indicated a moderate amount of exposure to other-race (non-Caucasian) faces overall, the monolingual and bilingual groups did not differ on several variables capturing infants' everyday face exposure (total number of faces seen, total number of non-Caucasian faces seen, and a diversity score reflecting the percentage of weekly hours infants were exposed to non-Caucasian faces relative to Caucasian faces).

Neither group showed the classic ORE pattern, suggesting that growing up in a multi-ethnic city might alter it. Moreover, bilinguals had higher recognition scores than monolinguals in response to both face types, indicating a general face recognition advantage in this population. Analyses of the face scanning data revealed that both groups of infants attended to the eyes most during habituation, but only bilinguals actively increased their attention to the eyes in the course of habituation. Importantly, increased attention to the eyes in the second part of habituation was related to higher recognition scores at test across the whole sample. Results are discussed in the context of the wider literature on the effect of early bilingual exposure on face perception as well as the development of the ORE in infancy.

P3-F-560 - Using head-mounted Eye Tracking to examine Cross-cultural differences in joint attention during parent-infant play

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Details

Introduction

Joint attention (JA) is thought to be crucial for socio-cognitive learning (Tomasallo & Farrar, 1986). Parent-infant dyads coordinate their multimodal behaviors during interaction - looking at and talking about objects, and this coordination predicts later vocabulary (Yu et al., 2019). The way parent-infants dyads coordinate JA behavior might differ between cultures. Research into cultural differences in parent-infant interactions America and Europeans countries are often seen as one “western culture” and are together compared to the “non-western” culture (e.g. India and China). Although there are similarities between the American and European cultures, differences also exist (Lansford, 2022). For example, studies indicate that US mothers focus more on cognitive stimulation than German mothers (e.g. Kirchhoff et al., 2019). The current explores cultural differences between parent-infant dyads from the US and the Netherlands in joint attention, mutual gaze and object naming.

Method

Data was collected in both US (n = 9) and Dutch (n = 10) dyads. The 19 parent-infant dyads (infants 23- to 34-months) wore wireless head-mounted eye trackers while playing. Dyads played for 10 minutes with 10 objects that were assumed to be unfamiliar to both Dutch and American infants. Head-mounted eye-tracking provide high-resolution data from infants and parent’s first-person view and allows to examine infants and parents looking behavior in real-time interactions. The eye-tracking data were used to investigate the amount and duration of joint attention and mutual gaze in parent-infant dyads. In addition, parents’ speech was recorded to examine the amount and duration of utterances in which objects were named.

Results

First, data indicated that US parents showed a greater amount of naming utterances per minute compared to Dutch parents, $t(17) = 2.94$, $p = .009$. However, the proportion of time naming objects during the play session did not differ between cultures, $t(17) = 1.61$, $p = .125$. Second, joint attention results showed that US parent-infant dyads looked per minute more to the same object at the same time than Dutch parents, $t(17) = 2.26$, $p = .037$. Nevertheless, the proportion of time spend in joint attention did not differ between cultures, $t(17) = .37$, $p = .716$. Third, the Dutch dyads demonstrated a higher amount of mutual gaze per minute compared to the US dyads, $t(17) = 3.64$, $p = .002$. Additionally, the proportion of total amount of time spend in mutual gaze was higher in the Dutch dyads compared to the US dyads, $t(17) = 3.31$, $p = .004$.

Conclusions

The findings suggest that US parents show more focus on cognitive stimulation during play since they more frequently name objects compared to Dutch parents. Since there are no differences in duration of naming utterances, Dutch parents may show a higher quality of naming utterances even though less frequent. More frequent episodes of mutual gaze in the Dutch dyads may indicate that Dutch parents emphasize more on social-emotional closeness during play.

P3-F-561 - Real-time relations between fundamental frequency of infant-directed speech and infant attention at 3 months

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Details

Drawing infants' attention to objects is crucial for early learning, and caregivers' infant-directed speech (IDS) plays a key role in guiding infants' attention (Spinelli et al., 2017). Research demonstrated that 6-month-old infants gazed more at a referential object when addressed with IDS compared to adult-directed speech (ADS; Senju & Csibra, 2008). IDS systematically differs from ADS in multiple prosodic aspects (Cox et al., 2022). Notably, the mean and standard deviation (*SD*) of fundamental frequency (F0), acoustically perceived as pitch and pitch variability, have been considered relevant for regulating infants' attention (Spinelli et al., 2017). Despite IDS being recognized as a dynamic process optimizing moment-to-moment attention (Nencheva & Lew-Williams, 2022), we know little about how IDS F0 features predict real-time infant attention during mother-infant interactions. This study examined dynamic relations between various F0 features and infant gaze toward interaction-related objects (e.g., the toy mother showed) during play at 3 months. We hypothesized that higher F0 mean and *SD* would predict increased attention to interaction-related objects. We further tested the moderating effect of infant attention to interaction-related objects *preceding IDS* (dichotomized as present versus absent) to assess whether F0 features attracted infants' attention to the interaction versus sustained attention that was already present. Complementing our hypothesis testing, we used a data-driven approach to assess

83 F0 features, which capture various aspects of the F0 dynamics, as potential predictors in an L1-regularized model, a machine learning model that allows comparison of the relative importance of many predictors.

Seventy-nine infants (36 girls) and their mothers (78% European American) participated in a laboratory visit at 3 months, during which dyads were video recorded during an 8-minute play session. Onset and offset times of maternal IDS were labeled offline. From each IDS utterance, we extracted 83 F0 features (e.g., mean, *SD*, maximum) using openSMILE 3.0 (Eyben et al., 2016), a software for extracting prosodic features from audio. To capture infant attention, we coded infants' gaze directions during the play session and computed the proportion of time infants gazed towards interaction-related objects within 5 seconds before and following each IDS.

Consistent with our hypothesis, two-level models showed that maternal IDS with a higher F0 *SD*, compared to her own mean level, induced longer gaze at interaction-related objects following IDS, controlling for infant gaze before IDS (see Table 1). Additionally, follow-up analyses indicated that this relation was only significant when infants exhibited gaze at interaction-related objects within 5 seconds *before* IDS (see Figure 1). F0 mean was not a significant predictor of infant attention. The L1-regularized two-level model showed that F0 maximum was the most predictive feature for infant attention to interaction-related objects among all F0 features.

Results from the traditional and regularized models converge and highlight the implication of F0 variability in maternal IDS for modulating infants' attention. Specifically, the within-dyad relations between F0 features (i.e., *SD* and maximum) and infant gaze at interaction-related objects suggest that IDS characterized by greater pitch variability and maximum pitch may prolong (versus attract) infants' attention to the interaction in the moment. This time-locked attentional modulation across auditory and visual stimuli may support real-time learning and contribute to long-term language development.

P3-F-562 - Modulation of infant heartbeat-evoked potential by expectation violation during social interaction

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Details

Introduction

The human brain is constantly predicting external information from our bodies (exteroception) and our internal physiological state (interoception). In adults, heartbeat-evoked potential (HEP) is a useful neural marker for the integration of exteroceptive and interoceptive information. Although previous research on infants has reported that infant HEP is associated with self-heartbeat perception and emotion perception (Maister et al., 2018), few studies have examined infant HEP in relation to prediction, particularly in the social context. Thus, the present study employed the still-face (SF) paradigm to determine how infant HEP is modulated during expectation violation and in the subsequent recovery process using simultaneous electroencephalogram (EEG) and electrocardiogram (ECG) measurements.

Methods

The study included 6- to 9-month-old infants (N = 10 currently, mean age = 253.20 days, SD = 24.39 days, 8 boys, N = 40 planned as the final sample). The SF paradigm consisted of a 2-min free-play (FP) phase, 2-min SF phase, and 2-min reunion (RU) phase, with the mother and infant seated face-to-face. To maximize ecological validity, physical contact between mother and infant was allowed during the FP and RU phases. Overall, we measured 32 channels of active electrode EEG (actiCAP slim, Brain Products, Germany) and 3 channels of ECG (AUX additional channels in actiCHamp plus, Brain Products), with a sampling rate of 1000 Hz. In the analysis, the infants' HEPs were preprocessed, filtered using a 0.1–40 Hz band-pass filter, averaged, and re-referenced; subsequently, independent principal component analysis was performed to remove artifacts due to the heartbeat. After the heartbeat R-peak was detected within each phase, the R-peak (−200 to 600 msec) was segmented. Finally, following visual and semi-automatic artifact removal, averaging and baseline correction (−200 to −50 msec) were performed.

Results and Discussion

Based on the findings, significant differences were observed in the HEP amplitude during the SF and RU phases compared with the FP phase in the fronto-central regions. In FC2 and Cz, the HEP amplitude was more positive in the SF phase compared with the FP phase (88 to 600 msec in FC6 and 41 to 183 msec in Cz after R-peak onset). Moreover, in Cz, the HEP amplitude was more positive in the RU phase compared with the FP phase (5 to 340 msec and 387 to 558 msec after R-peak onset) (Figure 1). The results indicate that the infant's HEP is modulated when the mother's response suddenly disappears during face-to-face interactions and in the subsequent recovery process. In future research, we will further investigate the relationship between infants' emotion expression at the behavioral level in the SF paradigm and the level of HEP modulation in the SF and RU phases. We will also examine the relationship between individual factors such as temperament (e.g., negative affect), resting-state EEG and ECG of infants, and HEP modulation in the SF paradigm.

P3-F-564 - Gist-based scene categorization in infants

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Details

Adults quickly recognize the overall meaning of visual scenes – their gist, such as "a park" or "a kitchen". However, little is known about the categorical knowledge of scenes and the extraction of scene gist in infants. Previous studies on infant categorization have shown that naming can aid categorizing objects. In our study, we investigated scene categorization based on gist and the impact of naming in infants, focusing on indoor man-made environments where recognizing the scene's gist depends on abstract properties.

In Experiment 1, we tested whether 12-month-olds (N=23) and 18-month-olds (N=24) would spontaneously categorize scenes with the same gist. We used two scene categories that included photos of scenes that should be familiar to infants: "mealtime" and "playtime" (see Figure 1). In each trial, infants

were presented sequentially with three different scenes from the same category. Following familiarization, two novel scenes were presented simultaneously in the test: one from the same and the other from the novel category. We hypothesized that if infants had recognized the scenes as belonging to one category during familiarization, they would look longer toward novel scene in the test. However, neither the 12-month-olds nor the 18-month-olds looked longer at the novel scene category during the test (12-month-olds: M=0.49, SD=0.05; 18-month-olds: M=0.51, SD=0.07). An independent preregistered replication of this study with four scene categories with 16-month-olds (N=30) found the same results (M=0.52, SD=0.06).

In Experiment 2, we tested whether naming could facilitate scene categorization. We used a similar procedure as in Experiment 1, except that during familiarization, a pseudoword paired with the scene (e.g., mealtime - "*padu*") was played with the presentation of each scene. The pair of test scenes were presented in silence. While 12-month-olds (N=23) did not look longer at the novel scene during the test (M=0.49, SD=0.05), 18-month-olds (N=23) looked significantly longer at the novel scene category (M=0.54, SD=0.06) compared to chance (t(22)=3.33, p=0.003, d=0.79, 95% CI=[0.51, 0.56]).

In Experiment 3, we tested whether 18-month-olds (N=23) could use labels to identify the novel exemplar of the familiarized category. The procedure was the same as in Experiment 2, except that during the test phase, a question was played, 'Where is the *padu*?' Here, we expected that if infants could extend the label to a novel member of the category, they should look longer at the scene from the familiarized category. Infants looked significantly longer at the familiar scene (M=0.54, SD=0.08) after the question (t(22)=2.33, p=0.029, d=0.49, 95% CI=[0.5, 0.58]).

Overall, our results show that 18-month-olds categorized scenes based on gist when the images were presented with a novel label in the familiarization phase (Experiment 2) and identified a scene with the same gist (Experiment 3) when prompted by a question containing the label. We showed for the first time that infants can categorize visual scenes based on abstract commonalities.

P3-F-565 - Temporal contingency between maternal touches and speech facilitates early receptive language development: A preliminary study with young Korean children

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Details

Maternal touches are known to be crucial for socio-emotional development in infants (Field, 2010). However, their impact on language acquisition is a newly emerging area of study. Recent research has shown that maternal touches often coincide with spoken words and are aligned with the boundaries of words (e.g., Ko et al., 2023). Expanding on these findings, previous studies have proposed that maternal touches may bolster infants' attention and assist in speech segmentation. Yet, to our knowledge, no studies have explored whether these aspects are linked to children's language proficiency. This study investigates the impact of temporal alignment between maternal touches and child-directed speech (CDS) on children's early language abilities.

This study utilizes videos from the Ko Corpus in CHILDES (Ko et al., 2020). The corpus consisted of dyads at varied developmental stages (N = 35, girls = 14; Age in months: M = 16.19, SD = 8.18, range = 6 - 30), each engaging in a 40-minute free-play session. Previous findings indicated a predominance of maternal touch in interactions with younger children, prompting the hypothesis that touch may aid young infants in discerning word boundaries and acquiring word meanings. Consequently, we focused solely on the subset of 21 infants under 16 months old (range = 6 to 16 months, mean age = 10 months 21 days, SD = 3 months 1 day), representing a developmental stage before infants grasp the concept of words and actively engage in word learning. Six minutes of interaction data, initially coded for Authors (2023), were examined for each mother-infant pair to investigate instances of maternal touches synchronized with and accompanied by words in CDS. Infants' language abilities were assessed using Sequenced Language Scale for Infant (SELSI; Kim, 2002), a standardized parent-report scale.

Multiple linear regression analyses were conducted and adjusted using a bootstrapping approach (replications = 10,000). Two independent variables were used. First, the ratio between touch and aligned words was calculated to investigate the effect of aligned touches, considering that a single maternal touch may encompass multiple words. Second, the number of words that appeared concurrently with touches was counted to understand the effect of concurrent touches with speech. Infants' age and the number of word tokens were included as covariates.

We found a significant effect of the sum of words concurred with touches ($\beta_{bootstrapped}$ = 0.048, $SE_{bootstrapped}$ = 0.033, 95% CI = 0.003, 0.107) and the ratio between touches and aligned words ($\beta_{bootstrapped}$ = 5.822, $SE_{bootstrapped}$ = 3.964, 95% CI = [1.542, 19.754]) on receptive language scores. These results suggest that infants achieved higher receptive language scores when their caregivers provided more touches with words and a greater proportion of alignment in word-touch boundaries compared to those whose caregivers did not. No other effects reached significance in the analyses exploring associations with expressive language outcomes.

Our data demonstrate that synchronized multimodal cues with speech positively impact children's language development. This study supports the notion that maternal touches aid infants in segmenting speech in real-time and their attention to encode sound-meaning mappings. These findings provide empirical evidence for the effectiveness of maternal touches in promoting young children's language acquisition.

P3-F-566 - The role of information gain and social interaction on infants' attention in a semi-naturalistic setting

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Details

According to the learning progress theory, infants' attention is guided by information in the environment (Poli et al., 2020). Yet, the role of social interaction and, in particular, the caregiver's behavior in interaction with information gain provided by the environment remains unclear. The aim of this combined behavioral and computational modeling project is to investigate infants' visual attention to informational structures in an interactive context.

More specifically, in this experiment 8.5- to 9.5-month-old infants and their caregiver will be sitting at a table watching toys appear in one of three boxes in front of them (fig. 1). For each trial, information gain (that is, information on where the toy appears) is calculated as Kullback-Leibler divergence. Based on Poli and colleagues (2020), we hypothesize that infants pay more attention during trials that offer more information gain as expressed in a lower probability of looking away during those trials.

Dyads are going to be divided into two different conditions: half of the caregivers will be instructed not to interfere during the experiment, while the other half will be encouraged to interact with their infants as they would do at home. On the basis of previous findings (Wass et al., 2018; Yu & Smith, 2016), we expect infants' attention to the toys to last longer overall for the group in which caregivers are free to interact with their infant, likely scaffolding their attention. We will examine whether infants' responsiveness to their caregiver varies depending on the amount of information gain.

We use a computational model for comparison with the actual behavior of the infants. Infants are assumed to perform as an ideal Bayesian learner would, keeping track of probabilities and updating them on each trial to successfully predict the location of the toy (Poli et al., 2020). The computational model (fig. 2) is built to determine which factors play a role in looking away. It takes into account information gain, presence or absence of scaffolding from the caregiver's side, time passed from the start of the experiment and differing attention spans of infants, represented hierarchically in the model. We will examine the role of the interactive context and how disengagement from the task might be mediated by caregivers' actions.

Infants' gaze direction and interaction between caregiver and infant will be captured by four video cameras. Infants' gaze behavior will be coded (looking at the setup/ looking at the caregiver/ inattention). Additionally, caregivers' behavior will be coded according to a coding scheme that includes vocalizations, pointing gestures, infant-directed touch.

The use of computational modeling techniques makes the study more robust and allows for a deeper analysis of the underlying mechanisms involved in infant attention. By combining behavioral observations with computational modeling, we can elucidate how infants integrate information from the environment with cues provided by their caregivers.

The study has been pre-registered (https://osf.io/gd6cb), and the data collection has been launched.

P3-G-567 - Neural specialization for face processing in the second year of life

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Details

Background: Event-related potentials (ERPs) provide critical insight into the developing specialization of neural responses to faces across development. The development of ERP components associated with specialized face processing in infancy (i.e., the N290 and P400) have been mapped across the first year (e.g., Guy et al., 2016; Conte et al., 2020). These components may represent precursors to an adult face-specialized component, the N170 (Halit et al., 2003; 2004). Adults demonstrate an inversion effect at the N170, evidenced by greater amplitude to inverted than upright faces (Rossion et al., 2000), which is not consistently observed in the first year. Investigation of face-sensitive ERP responses in the second year will provide insight into how they develop and mature over time.

Objective: The current study examines developmental change in the N290 and P400 to upright and inverted face and non-face stimuli across the second year. This work will provide insight into the developmental change in the amplitude and latency of the N290 and P400 components, associated with the face inversion effect, and may increase understanding of the role of the P400 in developing face specialization, which is currently unclear.

Method: Twelve-, 18-, and 24-month-old infants are being recruited cross-sectionally. EEG is recorded in response to four stimuli types—upright faces, inverted faces, upright houses, and inverted houses using a Magstim EGI 128-channel EEG system. Stimuli are presented for 500 ms with a random inter-stimulus interval of 500-1000 ms. The order of stimulus presentations are randomized and data collection occurs until infants become bored or fussy. Data collection is ongoing and 18 infants have completed the study thus far. Dedicated recruitment efforts are currently employed to ensure that data collection will be complete prior to the conference meeting.

Data analytic plan: ERPs will be segmented from 100 ms preceding stimulus onset to 1,000 ms post stimulus onset. The N290 and P400 will be analyzed for peak amplitude and latency using methods described in our previous research (Conte et al., 2020; Guy et al., 2016; 2021). ANOVAs will be conducted with age (3: 12-, 18-, 24-months) as a between-subjects factor and stimuli (4: upright houses, inverted houses, upright faces, inverted faces) as a within-subjects factor. Follow-up comparisons will probe specific differences between age and stimulus type.

Hypotheses: We hypothesize the latency of the N290 will decrease with age and its amplitude will be significantly greater to faces than houses across age groups, reflecting more selective activation to human faces over time. We also expect the inversion effect (i.e., greater N290 amplitude to inverted than upright faces) will become stronger with age. Inversion effects have been documented at the P400 (de Haan et al., 2002; Scott & Monesson, 2010) and the P400 is expected to differentiate upright and inverted faces, clarifying its role in face processing. Overall, this study will contribute important knowledge on developmental changes in neural response to human faces over the second year, including further elucidating the role of the P400 and charting the emergence of inversion effects in the N290.

P3-G-568 - Infant expectations that agents act efficiently and that group members act alike: pupil responses vs. looking-times

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Details

While infants expect agents to efficiently approach their instrumental goals (Csibra et al., 1999; Gergely et al., 1996) previous research has also shown that they expect agents from the same social group to act alike (Powell & Spelke, 2013). We investigated how these two expectations interact in a violation of expectancy paradigm using both traditional looking-time measure and pupil-dilation as preregistered exploratory analysis. In three experiments (*N* = 72), 11-month-old infants were familiarized with two agents moving above a barrier to obtain a goal object. Across the experiments, we manipulated the length of the barrier during the familiarization events such that infants viewed inefficient (Experiment 1) or efficient (Experiment 2-3) approaches to the goal object as performed by two agents who belonged to the same social group. During the test phase in all three experiments, infants observed a third agent approaching the same goal object over a short barrier. In Experiments 1 and 2, this test agent belonged to the same social group as the familiarization agents. In Experiment 3, however, the test agent belonged to a different group. Critically, in inefficient test trials infants observed the third agent moving in the same way as the two familiarization agents (i.e., going above the barrier to obtain the goal) while in efficient test trials, infants observed the third agent taking a direct path to obtain the goal. After being familiarized with efficient approaches (Experiments 2-3) infants showed greater pupil dilation in response to inefficient than to efficient test trials independently of the test agent's group membership. However, after being familiarized with inefficient approaches (Experiment 1) there was no difference in pupil dilation in response to two test trials. These exploratory pupillary findings demonstrate that 11-month-old infants' expectation of efficiency is robust and does not seem to be modulated by group membership information. The looking time findings mirrored the pattern of pupillary measure only for Experiment 3: After being familiarized with efficient approaches, infants looked longer to inefficient test trials than to efficient test trials when the test agent belonged to a different group than the familiarization agents. However, if the test agent belonged to the same group as the familiarization agents, infants showed no difference in cumulative looking times at two test trials, both after being familiarized to inefficient (Experiment 1) and to efficient (Experiment 2) approaches. Thus, while reactions of infants as measured by pupillometry could reflect the principle of rationality in infants' representation of instrumental agency, cumulative LT findings suggests that infants' expectation of efficiency might interact with their expectation that same-group members act alike. These discrepancies will be discussed in the light of recent advances in the use of pupil dilation in infant VoE paradigms.

P3-G-569 - Infants' expectations about language-group boundaries

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Details

Infants see language as marking social groups: they expect same-language speakers to be more likely to affiliate (Liberman et al., 2017) and share food preferences (Liberman et al., 2016) than different-language speakers. Here, we ask whether language familiarity drives the boundaries infants use to

create “groups”. One possibility is that infants expect same-language speakers to affiliate because speakers both use a familiar language and expect different-language speakers to disengage because one speaks a familiar language and the other speaks an unfamiliar language. Another possibility is that infants are tracking whether the speakers are using the same language as *each other*. Because infants can distinguish between phonemes even across languages they are not familiar with (Cheour et al., 1998), one way probe the impact of familiarity on infants’ expectations is to test how infants expect speakers of two *different* unfamiliar languages (e.g., French and Hebrew) to interact. If infants’ expectations are based on familiarity, then they may expect these speakers to affiliate. But, if infants are attending to whether the speakers are similar to *each other,* they may instead expect speakers of different unfamiliar languages to disengage.

We randomly assigned infants (N = 96; 12- to 17-months) to conditions in which two actors 1) spoke the same familiar language (i.e., English-English; FF), 2) spoke different languages, one familiar and one unfamiliar (e.g., English-Hebrew; FU), or 3) spoke different languages, both unfamiliar (e.g., French-Hebrew; UU). In all cases, after three familiarization videos presenting the actors’ language, infants saw six test trials which alternated between affiliation (actors interact positively by smiling, and saying “ay!”) and disengagement (actors interact negatively by frowning, and saying “humph!”). All infants saw two blocks, each presenting a different condition.

Infants’ natural attention was used to gauge their expectations about the actors’ likely relationship. We calculated the proportion of time each infant attended to affiliation (looking time to affiliation / total looking time to test trials), such that scores above .5 correspond to finding affiliation relatively more unexpected. A mixed-effects regression model revealed significant differences in attention between the familiar language condition (FF) and the two other conditions (FU: $B = 0.040$, $p = .047$; UU: $B = 0.42$, $p = .039$). These differences were due to infants finding affiliation unexpected when speakers used different languages, regardless of whether one of those languages was familiar ($t(55)= 2.712$, $p= .009$) or both were unfamiliar ($t(54)= 2.545$, $p= .014$), but not when speakers used the same (familiar) language ($t(55)= 0.223$, $p= .824$).

These results replicate previous studies demonstrating that infants expect same-language speakers, but not different-language speakers, to affiliate. Most interestingly, infants found it unexpected for people who spoke different languages to affiliate even when both languages were unfamiliar, suggesting that infants’ inferences may be based on whether speakers are similar to each other, rather than on whether speakers are similar to the infant. Further analyses will explore whether infants’ own linguistic experiences impact their expectations.

P3-G-570 - Co-development of Theory of Mind and Humor abilities in 18- to 37-month-olds

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Details

The main goal of this study was to investigate the relation between the development of Humor and Theory of Mind (ToM), specifically false belief understanding, in infants. Sixteen infants (7 girls, 9 boys) aged between 18 and 37 months (*M*=28,4, SD = 5.64) participated in this study.

For ToM hability, two protocols were proposed to the infants: false belief understanding through **1)** the visual paradigm of Anticipatory Looking (Senju et al., 2011) and **2)** the Helping paradigm (Buttelmann et al., 2009). Infants' Humor understanding was directly assessed through observations of their behavioral reactions to non-verbal humoristic videos. In parallel, parents filled out a questionnaire about humor practice within the family and another about their infant's ToM and Social Skills. The ToM and Social Skills questionnaire was adapted from AESE (Comte-Gervais et al., 2001) and Vineland II (Sparrow et al., 2012). The humor questionnaire was based on Solomiac et al. (2021) and Norimatsu et al. (2021). Language skills were also evaluated as a control measure to ensure that participants understood experimenters' instructions during the experiment. Firstly, our results showed that 88.9% of infants aged 18 to 29 months and 71.4% of 30- to 37-month-olds succeed in Anticipatory looking task. As for the Helping task, 50% of the 18–29-month-olds, and 100% of the 30–37-month-olds succeeded. These results suggest an early development of false belief understanding (before 4 years) which is coherent with recent literature on this topic (Baillargeon et al., 2010; Senju et al., 2011; Sodian et al., 2020). Secondly, regarding the relation between Humor and ToM, we observed a positive yet non-significant relationship between infants' performances measurements in ToM tasks and their Humor understanding (r = .09, n.s, Spearman). When using composite scores of ToM (including Anticipatory looking, Helping and parental reports of ToM ability) and Humor (including infant behavioral humor understanding and parental reports of humor understanding and production), the same positive yet non statistically significant relation was found (r = .38, n.s, Spearman). Finally, the results of a linear regression model indicate a positive and moderate correlation between Humor understanding and production scores (parents' report) and infants' performances in ToM tasks (R=.635). This relation is coherent with recent literature which indicates that humor might predict the development of social cognition, including ToM abilities (Soy Telli & Hoicka, 2022). However, because of the non-consistency between and direct (infants' performance) and indirect (parental reports) measures of these two constructs, we must take these interpretations with caution. This limit in interpretation prompts us to reconsider how Humor and ToM are investigated in both laboratory settings and via parental reports.

P3-G-571 - Behavioral correlates of social touch processing in infant fMRI

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Details

In early development, social touch, defined as non-sexual, pleasant, and affiliative touch (Cascio et al., 2019), is implicated in emerging communication skills, cognitive development, and socio-emotional learning (Hertenstein, 2002). Understanding the neurological correlates of social touch processing in infancy is critical for understanding healthy brain and behavioral development. In adults, social touch, as compared to non-social touch, preferentially activates subcortical brain regions (e.g., insula and amygdala) related to processing the emotional valence of incoming stimuli (Gothard & Fuglevand, 2022; Kraus et al., 2019). Infant functional magnetic resonance imaging (fMRI) has been used only once to

study social touch, but failed to use a non-social control condition, making it difficult to discern whether the neural activation patterns reported were specific to social touch or to the global processing of tactile information (Tuulari et al., 2017). Additionally, they only analyzed neural regions previously identified in the adult literature. Given infants' rapid synaptogenesis and axonal growth patterns, it is likely that other brain regions may be contributing to tactile processing. Therefore, it is critical to perform a whole-brain analysis to better understand how other areas may be affecting sensory processing early in development. While understanding mechanistic properties are important to elucidating healthy growth trajectories, it is also critical to assess whether these neural properties result in increases in overt social behavior to ensure the clinical relevance of our results.

Our preregistered study (https://osf.io/2htzj) aims to 1) assess the neural correlates of social compared to non-social touch using fMRI in early infancy and 2) to assess the association between the neural activation patterns associated with social sensory processing and infant behavior. We hypothesize that there will be greater neural responses in subcortical areas related to emotion processing in infants who display greater amounts of social behavior. Eighty-five zero- to four-month-old infants and their parents will be recruited through the University of Virginia's hospital medical record system. Infants will undergo a fMRI while being gently stroked with a paintbrush to simulate conditions of social and non-social touch. During the social condition, infants will be stroked at a rate of 3 cm/second on their left shin, which is the optimal rate for eliciting a pleasant and social response to touch (Triscoli et al., 2014). During the non-social condition, a piece of medical-grade malleable plastic will be placed between the shin and the paintbrush, inhibiting the response. Images will be preprocessed and a whole-brain analysis with a social and non-social contrast will be performed using FSL. Infant social behavior will be measured using the Infant-Behavior Questionnaire-Revised, which quantifies twelve domains of infant behavior (The Infant Behavior Questionnaire (IBQ and IBQ-R), 1980). Additionally, parent and infant will undergo a five-minute video-recorded feeding interaction, which will be behaviorally coded for infant-initiated social behavior using the Maternal Infant Synchrony Scale. A general linear model in FSL will assess the relationship of the infants' neural response on their overt social behavior. Results from this study will elucidate biological mechanisms of social touch and provide clinical relevance to the preexisting research.

P3-G-572 - Toddlers do not preferentially transmit generalizable information to others

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Details

Children actively and selectively transmit information to others based on the type of information and the context during learning. Four- to 7-year-old children expect generalizable information to be widely known by others, and they preferentially transmit generalizable information to others in teaching-like contexts. Although 2-year-old children are able to distinguish between generalizable and non-generalizable information, it is not known whether they likewise transmit generalizable information selectively. We designed a behavioral study to address this question (accepted as a Registered Report in Developmental Science, https://osf.io/aqtwr/) Forty-nine 2-year-old children (*Mage* = 24.43 months, Range = 22.67– 25.70 months, 25 females) were presented with three novel boxes, identical except their

color. In each box, one of two equally salient actions led to a generalizable outcome (e.g., playing a (different) tune in each box), whereas the other led to a non-generalizable outcome (e.g., turning on a light, vibrating the box, or making a noise). In the discovery phase, children had a chance to discover the functions of each box presented one-by-one. Then, in the exploration phase, they were given the opportunity to independently explore all three boxes presented together. Finally, in the transmission phase, an ignorant recipient entered the room and asked the child to show them how these toys work. We measured whether children preferentially transmitted either generalizable or non-generalizable information when they were asked to demonstrate the function of the toys to a naïve adult. We posited that a preference for generalizable information in transmission might be reflected in two ways. The first was that children might transmit generalizable information preferentially and would choose the generalizable function as the first to be transmitted to an ignorant adult ("initial preference" hypothesis). Additionally, they might transmit the generalizability of the information. To do that the child must transmit different instances of this information (e.g., the same-type button playing different tunes across boxes). We evaluated this "systematicpreference" hypothesis by investigating the second function that children showed to the learner on a different box after showing a generalizable function (as the first function). We found that children did not show any preference for transmitting generalizable information as the first and (i.e. "initial preference" hypothesis, $W(48) = 304.00$, $p = .213$, $r = 0.226$, $BF01 = 3.404$) the second function (i.e., "systematic preference" hypothesis, ($W(16) = 72.00$, $p = .829$, $r = -0.059$, $BF01 = 3.204$) transmitted generalizable information to others in a teaching like context. Finally, toddlers' behavior in the Exploration and Transmission phases was similar, they neither preferentially (nor systematically) explored nor transmitted either type of information. These findings are discussed with respect to toddlers' selectivity in transmitting information but also the development of sensitivity to information generalizability.

P3-G-573 - Investigating 3- and 11-month-olds' understanding of social versus nonsocial goals

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Details

In the last two decades, studies have found evidence suggesting that infants are not only capable of reasoning about lower-level mental states such as goals (e.g. Cannon & Woodward, 2012; Woodward, 1998), but also more sophisticated mental states (e.g. false beliefs; Onishi & Baillargeon, 2005; Southgate et al., 2007; Surian et al., 2007). However, there are troubling failed replications of key findings for both basic (i.e. goals; Ganglmayer et al., 2019) and advanced forms of mentalizing (e.g. false belief; Kampis et al., 2021). What drives these discrepancies? Perhaps infants may be more likely to mentalize under certain circumstances; for instance, Woo et al. (2023) posit that mentalizing is facilitated by *social contexts*. Indeed, given humans' incredibly social nature, it is notable that most of the goals and beliefs that infants are asked to reason about refer to inanimate objects. In two pre-registered experiments, we use goal-attribution of social- versus object-goals as a case study to investigate whether social contexts facilitate infants' mentalizing.

Exp.1 adapted a classic violation-of-expectation paradigm measuring goal-attribution (Woodward, 1998). Thirteen (target N=64) 3-month-old infants watched videos featuring five elements: A

protagonist, two female human agents wearing different color t-shirts, and two inanimate objects. In the Social condition, the two agents are in the foreground diagonally in front of the protagonist, representing possible goals, with the two objects in the background behind the protagonist. In the Nonsocial condition, the objects are in front and the agents behind. Infants were first habituated to videos in which the protagonist walked forward, stood between the foreground agents/objects briefly, then walked towards and touched one of the agents/objects. After infants were habituated, the foreground agents/objects switched locations, and infants watched the protagonist approach either the same agent/object (new path) or the other agent/object (new goal) on 6 alternating trials. Preliminary results show that infants looked longer during new goal trials (11.39s) than new path trials (9.32s) in the Social condition, but looked equally in the Nonsocial condition (16.36s vs 16.04s). These patterns suggest that infants may be more likely to attribute social-goals.

Exp.2 adapted the same stimuli to investigate anticipatory looking using an eye-tracking paradigm (Cannon & Woodward, 2012). Nineteen (target N=64) 11-month-olds first watched 3 familiarization trials that were identical to the habituation events in Exp.1. Then, infants watched a test trial where the protagonist walked forward and paused before she approached either object. This sequence was repeated 4 times, and infants' anticipatory-eye-gaze (AEM) towards the foreground targets was measured. Preliminary results revealed that infants were more likely to direct AEMs towards the incorrect target in the Nonsocial (100%) than the Social condition (51.52%; p=.026). This suggests that when observing the protagonist approach an inanimate object, they strongly attributed a location-based goal (Ganglmeyer et al., 2019), but may have inconsistently attributed location- and agent-based goals in the Social condition. The poster will present confirmatory and exploratory analyses for both studies featuring the completed dataset.

P3-G-574 - Do individual differences in attachment styles predict sociomoral behaviours in infancy and toddlerhood? A longitudinal perspective

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Details

Attachment theory (AT; Bowlby, 1962) proposes that the early infant-caregiver relationship facilitates the development of morally-relevant behaviours (Deneault, et al., 2023). According to AT, sensitive parenting builds secure parent-child relationships which allows young children to hold positive views of future interaction partners and develop emotion-regulation, both of which promote prosocial behaviours (Beier, et al., 2019). Prior research indicates that attachment style is associated with some of the earliest forms of morally-relevant behaviour, including actions like helping, sharing, and comforting (Beier et al., 2019) and emotional responses such as empathy (Bischof-Köhler, 2000); however, a recent study (Loheide-Niesmann, 2020) found no association between infants' attachment patterns and their sociomoral preferences for prosocial/antisocial agents. Attachment style in this study, however, was

measured by parent-report rather than using a behavioural measure such as the strange situation paradigm (SSP; Ainsworth, 1978). Here, we aim to examine relationships between attachment style (assessed using SSP) and infants' sociomoral preferences, as well as other proposed morally-relevant behaviours that emerge during infancy and toddlerhood.

Data was collected as part of an ongoing large-scale longitudinal project on social and moral development. At 12 months old, infants took part in a slightly modified (due to Covid-19) version of the SSP (Ainsworth et al., 1978) in which their behaviours when separated and reunited with their caregiver, were used to classify their attachment style (secure/insecure). The infants' preferences for helpful/unhelpful puppets were assessed at 6 and 24 months old using two versions of a social evaluation paradigm (SET; Hamlin & Wynn, 2011). During the SET infants watched a puppet show in which a protagonist is striving towards a goal (retreiving a dropped ball, opening a box) and is helped and hindered by two other puppets. Infants were then asked to "choose" between the helper and hinderer, either by reaching (at 6 months) or rewarding with a treat (at 24 months). At 17 months old, infants took part in two prosocial behaviour tasks (each scored 0 - 3) in which they were prompted non-verbally to retrieve a dropped clothespin for a researcher (instrumental helping; Warneken & Tomasello, 2006) and share their own food with a researcher who received none (altruistic sharing; Dunfield et al., 2011). Finally, at 29 months old, infants' empathic behaviour (scored 0 - 4) towards an 'injured' researcher was assessed (comforting; Dunfield et al.,2011).

Preliminary analyses (n = 49) indicate that individual differences in infant's secure attachment is not associated with their helper/hinder preferences at 6 or 24 months old, a replication of Loheide-Neismann (2020). No significant associations with other prosocial variables were found; Numerically, insecure (vs. secure) infants exhibited higher empathy scores (1.5 vs. 2.5), and more secure (vs. insecure) infants shared food with a needy researcher (43% vs. 14%), suggesting that attachment security may have some impact on toddlers' sociomoral behaviours. Data collection and coding is ongoing, with mixed-effect models planned for the larger final sample (target *n* = 100). These analyses will inform our understanding of the implications of attachment style for the earliest forms of morally-relevant behaviour.

P3-G-576 - Factive and non-factive mentalization: exploring the underlying systems in infants and adults

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Details

Factive mental states, such as knowledge and ignorance, are tied to the way one takes the world to be. On the other hand, non-factive mental states, including false and true beliefs are not tied to the way one takes the world to be (Phillips et al, 2021). The current study aims to explore whether factive and non-factive mental state attributions recruit the same representational structures, and thus belong to the same or separate systems. The relationship between factive and non-factive mentalization is studied by examining the way updates happen between them, relying on the assumption that transfer within one system should occur faster than between systems. That is, if factive and non-factive mentalization belong

to the same system, updating a non-factive mental state to another non-factive mental state (non-switch conditions, e.g. false belief to true belief), should be easier, than updating from a non-factive mental state to a factive mental state (switch conditions, e.g. false belief to ignorance).

In the first experiment adult participants watch animated videos of a ball moving and hiding between two boxes, while an Agent is either witnessing or not witnessing the movement of the ball. During test trials, updating a previously attributed mental state is needed. Various versions of such mental state updates were shown to the participants (from false belief to knowledge/true belief/ignorance and from true belief to knowledge/false belief/ignorance). At the end of each video, both of the boxes open at the same time, and the ball reappears at the location that is congruent with reality. The reactive saccadic reaction to the outcome of these scenes is measured, as a proxy for the ease of updating from certain representations or systems to others (Kenward et al., 2017). Results show that participants (n = 32) did not differ in their saccadic reaction when updates happened between two non-factive mental states (FBtoTB: M = 421, TBtoFB: M = 416, p = 1.0). However, saccadic latency was slower in the case of updates from one non-factive mental state to a factive mental state (e.g. FBtoIG: M = 486) compared to updates between non-factive mental states (FBtoTB: M = 421, $p < 0.001$) in all cases. The results indicate that in adults factive mental states and non-factive mental states seem to be processed by separate representational systems.

In the second experiment, we aimed to tackle on such a separation early in development. Here 18-month-old infants (planned sample n = 48, 2 groups) watch videos containing updates from false belief to true belief (non-switch condition) and from false belief to knowledge (switch condition-Gr 1) or from false belief to ignorance (switch condition-Gr2). The same saccadic reaction measurement will be applied at the end of the videos. A pilot with n = 8 infants was carried out in order to ensure that infants follow the videos and that they provide valid saccades, which were confirmed. The final sample will be presented at the conference. Preregistration of the infant experiment can be found here: https://aspredicted.org/r5zu7.pdf

P3-G-577 - Age-related gender preference differences in infants: the influence of gender distinctiveness

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Details

The early development of face representation is largely shaped by infants' experiences, encompassing predominantly female faces (Ramsay, 2005). As a result, young infants (3-4 months) exhibit an attentional bias towards female over male faces (Quinn et al., 2002). However, it is unclear how generalized an infant's female face preference (FFP) is, particularly when it comes to faces from different age categories. To this end, the current study investigated infants' FFP with respect to the age of the face (children, adolescents, young adults, middle-aged adults, and senior adults), and the age of the infant (Experiment 1), as well as how gender distinctiveness affects this preference (Experiment 2).

Thirty White infants of 4 to 9.2 months (15 females) participated in experiment 1. In each trial, they saw a pair of female and male faces of similar age on the screen for 5 seconds. Faces of different ages were presented across trials (within-subject design).

We analyzed the infants' FFP by calculating it as the looking time for the female faces as a proportion of the combined looking time for both the male and female faces. We used a 2-by-5 repeated-measures ANOVA with face-age as a within-subject factor and infant-age as a between-subject factor (infants were split into two groups, younger and older, from the median age of 7.6 months). We found a significant effect of infant-age (p=.017) with the younger group (m=5.44 months, FFP=50%) showing a stronger FFP than the older group (m=8.47 months, FFP=47%), replicating previous findings (Liu et al., 2015). We also found a significant effect of face-age (p=.009) indicating difference in the strength of the FFP depending on this factor. A series of individual one-sample t-tests against chance of the FFP for different face-age group from the younger infants (Fig1) revealed that only the younger adult faces produced a significant FFP (p=.023). These results suggest that the FFP is stronger among younger infants and is strongest for young adult faces.

In Experiment 2, we tested 23 White infants (12 females) using a similar approach to Experiment 1, but in a 2-by-2 within-subject design. The face pairs featured either a high or low degree of distinctiveness from one another, and each pair belonged to either the younger adult or older adult category.

We analyzed FFP values using a 2-by-2 repeated-measures ANOVA with face-age and face-contrast as within-subject factors. We found a significant effect of face-age (p=.01), with the younger faces producing a higher mean FP (54%) than the older faces (51%). High-distinctiveness faces produced slightly higher FFPs (53%) than low-distinctiveness faces (52%), but not significantly (p=.533). We then tested mean FFP values in the 4 combinations of factors against chance (50%) using one-sample t-tests. We found that both low-distinctiveness (FFP=53%, p=.024) and high-distinctiveness (FFP=55%, p=.002) younger faces produced FFPs significantly higher than chance (0.5), while neither high- or low-contrast older faces showed significant effects (Fig2).

Our experiments therefore indicate that FFP is strongest for younger faces, among younger infants, and is robust even under low-distinctiveness conditions.

P3-G-578 - "Wow, that is amazing!" - 18-month-olds can extract transient action effects as the reason for adults' emotional expressions

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Details

While most studies investigating action-goal understanding in early childhood focus on objects as goals, many real-life action goals consist of transient effects in the environment (e.g., a light) that are only perceivable after the performance of a particular action (e.g., pressing a button).

We designed a violation-of expectation eye-tracking study to examine whether 18-month-olds can relate another person's emotional expression to a transient action effect. Infants were presented with videos depicting one "actor" in screen center and two "emoters" sitting to the actor's sides. Each video started with the actor performing a simple action on one of five objects, thereby eliciting a transient sound or light effect. Upon appearance of the effect, one of the emoters reacted positively with verbal and facial expressions. During familiarization, infants watched eight videos including different actions and objects, but with a constant pairing of emoter and reacted-to action effect (e.g., emoter A – sound, emoter B – light). In four subsequent test videos with a novel object, each emoter reacted either congruently (to the same effect) or incongruently (to the other effect) with regard to the familiarization. Congruent and incongruent trials were presented in alternating order, with half of the infants starting with a congruent and the other half with an incongruent trial.

We analyzed infants' pupil dilation and looking times as complementary measures for surprise. A cluster-based permutation analysis on infants' pupil size (n=36; age: M=17.97 months, SD=0.32; 50% female) revealed significantly larger pupil dilation during incongruent compared to congruent test videos in a window of 940-2360ms after the onset of the emoter's reaction (p<.05; Figure 1). The timing of the pupil-dilation differences indicates a cognitive (instead of an early perceptual) process being causal for the condition differences in the 18-month-olds' pupil dilation. Furthermore, the pupil-dilation measures differ in the expected direction, indicating greater cognitive load (conceivably surprise) during videos where an emoter showed a positive reaction to an action effect they had previously ignored.

In line with these results, a complementary generalized linear mixed effects model on infants' looking times (n=43; age: M=17.89 months, SD=0.30; 51% female) at a still frame at the end of the video depicting the "outcome" (the action effect and the emoter reacting) showed longer looking times at incongruent (M=20.6s, SD=14.9) compared to congruent (M=17.9s, SD=11.6) test videos (0.23 ± 0.14, z=1.61, p=.04; Figure 2).

Together, these findings from converging methods indicate that, during familiarization, 18-month-olds built an expectation with regard to which emoter should show a positive emotional expression in reaction to a specific action effect (light vs. sound). Because the only aspect varied in the test videos was the emoter-effect pairing, our results indicate that infants extracted the action effect as the reason for the emoter's emotional expression. This ability to identify and represent relations between a person's emotions and transient action effects builds the base for a complex and adult-like action-goal understanding, because a person's emotional expressions are an important source for predicting this person's further goal-directed actions already in early infancy (Phillips et al., 2002).

P3-G-579 - Imagining the short-term and long-term future from another's perspective

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Details

Episodic future thinking, the ability to self-project into the future to anticipate a future event, develops rapidly from 2-5 years old (Atance & Meltzoff, 2005). Intuitively, it seems that imagining the future from

another person's perspective would be more difficult than doing so for oneself as the former scenario requires Theory of Mind. However, Belanger et al. (2014) found the opposite when asking children whether they or an age-matched peer would prefer a child-item (e.g., juice) or an adult-item (e.g., coffee) when they are grown-up. Results demonstrated that children were better able to choose the correct option (i.e., coffee) when they adopted the perspective of a peer, possibly because they didn't need to inhibit their own preference. Our experiment extends upon these findings with the addition of another condition where children chose between a daytime-item (e.g., t-shirt) and a nighttime-item (e.g., pajamas) to use tonight. In the tonight (short-term) condition, there should no longer be a benefit of thinking for a peer as children should more easily be able to draw upon what they usually prefer at night.

We tested 114 children [23 2-year-olds (M=31.70, SD=4.13, 12 females), 40 3-year-olds (M=41.68, SD=4.71, 15 females), 32 4-year-olds (M=53.06, SD=6.46, 16 females), and 29 5-year-olds (M=63.66, SD=4.39, 19 females)]. Our task consisted of children selecting which object they would like in the future. There were two within-participants conditions. The long-term condition is similar to Belanger et al.'s (2014) procedure, where one object is the child-item and one object is the adult-item. Our new condition, short-term, required the child to select between a daytime-item and a nighttime-item. There were also two between-participants conditions, self (choosing for oneself) and other (choosing for a peer). Two stimuli were presented in each trial, one at a time, and then both together on a computer screen. Additional questions were asked to exclude trials where the child displayed atypical preferences or misunderstanding of what typical adults like.

Overall, 2-year-olds performed significantly below chance in the long-term condition (M=0.29, 95% CI[0.12, 0.47], p=0.025) and at chance in the short-term condition (M=0.54, 95% CI[0.31, 0.78], p=0.689). Using a generalized linear mixed model, we found that age in months (p<0.001), the between-participants conditions (p=0.001), the within-participants conditions (p<0.001), and the interaction between the between- and within-participants conditions (p=0.015) were good predictors of performance on the task. Older children had more trials included in the task overall as well as better performance on the trials that were included. As we expected, in the long-term condition, the other condition resulted in significantly better performance than the self condition (p=0.007) while in the short-term condition, the other and self conditions did not differ (p=0.98). These results suggest that thinking about the future from another person's perspective is most beneficial when the future context is further in time (being an adult) rather than closer (tonight).

P3-G-580 - Exploring infants' Response to Joint Attention: insights from Pupillometry

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Details

Response to Joint Attention (RJA) is the ability to track and respond to a partner's head or gaze direction to share a reference point, contributing to the acquisition of advanced socio-cognitive skills. Achieving effective RJA requires integrating different attentional components (Parsons et al., 2019). Infants initially

engage by showing interest in their social partner's faces, then disengage attention to follow their partner's gaze, and finally deploy and sustain attention on the object being looked at. This latter ability demonstrates understanding the partner's gaze as referential, that is, object-directed, a hallmark of successful RJA. The vast majority of the studies aimed at disentangling the attentional processes involved in RJA measured looking times. Here, we aimed to delve deeper into these processes by measuring pupil dilation as well, which may provide a more direct index of the attentional resources associated with the different components of RJA. The efficiency of RJA was measured in infants aged 10 to 12 months (N = 19) using a computerized infant-controlled eye-tracking procedure (Tobii Spectrum) in which participants were presented with 20 trials, each composed of 3 phases (Figure 1). Phase 1 showed a central talking face and two identical pinwheels positioned to the left and right of the face. In Phase 2, the face turned towards one of the pinwheels (target). In Phase 3, if/when the infant's gaze reached the target, it initiated a spinning motion with a sound after a variable time delay (200-1000 ms range). This manipulation allowed us to explore the infant's attentional strategy once they had oriented towards the referent. Since there is high individual variability in RJA associated with environment and temperamental variables (Vaughan et al., 2007), we also measured temperamental traits with the IBQ-R Very Short Form (Putnam et al., 2014). The analyses on looking times and pupil dilation revealed that, across the three phases, infants exhibited longer fixation and larger pupil dilation on the face compared to both the cued and uncued pinwheels (p<.001). Although looking times on the face decreased from Phase 1 to Phase 3 (p<.001), pupil dilation remained stable across the three phases (p>.99), suggesting sustained attentional engagement across all RJA components. Results on Phases 2 and 3 revealed that looking times decreased across time delays (p<.001), and were longer on the face than on the congruent target (p<.001). In contrast, pupil dilatation did not differ between the face and the congruent target (ps>.055), suggesting that infants' attentional resources were indeed distributed between the agent and the referent. Finally, the analysis of pupil response and temperament traits indicates that a positive, organized temperamental style is associated with diffuse attention spread across the face and the target, while a negative temperamental style is associated with a primary focus on the face and the congruent target. These findings reinforce the importance of pupillometry as a valuable tool for elucidating cognitive processes underlying visual fixation and a sensitive measure of interindividual variability in the deployment of visual attention in social contexts.

P3-G-581 - Measuring closeness between infant grandchildren and their grandparents

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Details

Affectual solidarity - feelings of reciprocated closeness - between grandparents and their grandchildren has been positively linked to the wellbeing of both (e.g., Duflos et al., 2022). However, it is not clear whether affectual solidarity predicts positive outcomes when grandchildren are infants. A limitation on this line of enquiry is that existing measures of affectual solidarity include items about mutual trust, respect, and understanding that may be developmentally inappropriate for adult-infant relationships. Other instruments measure closeness between cohabiting and/or primary caregiving adults and

children. In the current pre-registered study we develop a measure of closeness for use with non-cohabiting grandparents of infant grandchildren, adapted from existing instruments (Dibble et al., 2012; Driscoll & Pianta, 1992; Yarosh et al., 2014).

Grandparents of children aged 18 months to 5 years in the UK and Ireland (N = 302) rated their agreement with 25 statements. An exploratory factor analysis yielded two factors representing closeness (11 items, $\alpha = .91$: feeling warmth, intimacy, and connectedness) and holding in mind (6 items, $\alpha = .90$: thinking about and prioritizing their grandchildren), which were positively correlated ($r = .76$, $p < .05$).

Next, a sample of grandparents in the US (N= 857) rated their agreement with the remaining statements, and a confirmatory factor analysis (CFA) indicated items loaded as expected (>.5). Model fit evaluation suggested some misspecification. To identify potentially problematic items, we used statistical criteria (modification indices, inter-item correlations) and data from cognitive interviews (Karabenick et al., 2007) with 20 grandparents. Participants interpreted each item's meaning, gave a rating, and provided recollections and examples. Two coders rated whether participants interpreted the item as expected, the congruency of their rating and explanation, and holistic item understanding. Items receiving a holistic score representing "understood the fundamental meaning" from either coder for fewer than 75% of participants, a modification index >10, or an inter-item correlation >.8 were considered for removal. Two researchers qualitatively coded type and degree of misunderstanding. Initial analyses indicated that differentiation between items may be easier for grandparents of older children, who have more language and varied activities, than for grandparents of infants. For example, some grandparents relied extensively on how much the grandchild displayed positive affect during their time together to answer a range of items: having a strong connection, being close, and having a warm relationship. Alternatively, some grandparents relied on their own feelings rather than the bidirectional feelings of both parties when infants' perspectives were difficult to intuit. A complete presentation of the impact of the qualitative themes on item selection will be available at the conference, focusing on grandparents of children below age 3.

An additional sample of UK and Ireland-based grandparents will be collected, a CFA conducted on the final item set, and an SEM conducted to show that frequency of contact and quality of parent-grandparent relationship relate to grandparent-infant closeness (e.g., Attar-Schwartz et al., 2009). This process will ultimately enable the investigation of grandparent-grandchild relationships during the understudied period of grandchild infancy.

P3-G-582 - Young infants' expectations of others' helping behavior

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Details

Do young infants expect a person to help (vs. ignore or hinder) another one? According to one account of early moral cognition (Ting et al., 2020), infants hold these expectations if the two individuals belong to one social group (e.g., speaking the same language) based on a principle of ingroup support (i.e.,

ingroup members should support and show preference for and loyalty to one another). Without specified group membership, if the individuals are of one moral circle, e.g., humans, infants expect them not to cause significant harm to each other, based on a principle of harm avoidance, and accept when one individual ignores another's need for help. Studies supporting this principle-based account are conducted with infants older than 12m using scenarios involving 3 people and include group membership manipulations (Jin & Baillargeon, 2017; Ting et al., 2019). Evidence for young infants' helping expectations remains limited.

Groundbreaking work by Hamlin and colleagues on early social evaluation skills (e.g., Hamlin & Wynn, 2011; Hamlin et al., 2007) provide important insights. Infants at 3m prefer an agent who helped a protagonist achieve its goal (e.g., going up a hill) over a hinderer who knocked the protagonist downhill (Hamlin & Wynn, 2011). To ensure equivalent exposure to the helping and hindering events, infants were habituated to these events before their preferences were examined. They looked equally at the helping and hindering events, suggesting that they hold no expectations about these interactions. Additionally, the agents and the protagonists used in these studies were animal puppets of different kinds or different geometric shapes, pointing to the possibility that infants considered them of a different moral circle.

Do young infants hold helping expectations regarding two human agents' interactions? The present study examines this question. In Experiment1 with a between-subject design, infants at 5.5m (N=36) watched events in which one agent (A1) put various pieces (eyes, nose, teeth) onto a toy (Mr. Potato head) as another agent (A2) looked on. A hat piece was out of A1's reach. After A1 failed to obtain the hat, she left the scene. Next, A2 moved the hat close to the toy (help), even further (hinder), or moved it and then back to its original position (ignore). Infants in the hinder condition looked at the event (M=26.46 s, SD=12.63) reliably longer than those in the help condition (M=15.49 s, SD=5.54), t=2.76, two-tailed p=0.012, as did infants in the ignore condition (M=26.82 s, SD=9.07), t=3.69, two-tailed p=0.001. An ongoing Experiment2 is similar except that A1 has no need for help because she does not attempt to reach for the hat piece before leaving the scene. Infants' looking times in this control experiment differ from those of Experiment1. Together, these results would suggest that young infants expect a person to help, but not ignore or hinder, another person in need. This would suggest that at this young age, infants expect ingroup support in people's interactions, without specific group membership markers, hence shedding new light on the development of the concepts of ingroup/outgroup and moral circles.

P3-G-583 - Predicting variance in quality at different levels of early childhood education and care: Examining an additional unit of analysis

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Details

Most children worldwide attend some form of early childhood education and care (ECEC) arrangement outside their homes (UNICEF, 2023). Extensive research on ECEC settings has found that high-quality ECEC services directly correlate with positive child outcomes such as language and cognitive

development and social and emotional competence (Burchinal et al., 2011). However, many associations between ECEC quality and child outcomes have been weaker than expected. This raises questions about whether we are measuring quality at the right level, which is currently primarily assessed at higher levels of the ECEC structure (i.e., centres and classrooms).

In this paper, we investigate variance in quality at different levels of the ECEC structure using cross-sectional, multi-level modelling. We examine variance in quality using the validated Responsive Interactions for Learning – Educator-Child Dyad scale (Burns et al., 2023), which measures the quality of children's individual experiences with an educator. We further investigate the role of educator/child ratios and the type of activity they were engaged in (routine vs. structured) that may impact the experiences of individual children in the same context and the quality of the interactions that educators can direct toward them.

This study used data from 30 ECEC centres across 42 classrooms and 96 educators. A total of 694 dyadic interactions were observed and coded. The number of educators per classroom ranged from 1 to 5 (M = 2.28, SD = 0.74), with each centre having 1 to 8 educators (M = 3.20, SD = 1.42). We found that the highest variance in interaction quality scores occurred at the educator-child dyad level (75%), followed by the educator level (25%; see Table 1). Interaction quality decreased as the number of participating children increased, and routine activities (e.g., transitions and snack time) showed lower quality scores than structured activities (e.g., puzzles; see Table 2). The relationship between the number of children and quality was weaker for routine activities.

This study underscores the significance of individual experiences and focuses on the appropriate level of measurement in quality evaluations in the interactions of young children and their caregivers. The findings also highlight potential focus areas for educator training and professional development.

P3-G-584 - 15-Month-old toddlers' understanding of imitative and instrumental actions

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Details

Imitation is a powerful early emerging social cue humans use to learn from, engage with, and conform to others. However, not all shared actions are imitative. For example, we might interpret someone doing "the lawnmower" dance move after we do as imitation; they communicate a social goal: Let's dance together! In contrast, a neighbor mowing their lawn in the same way we mow ours probably just wants to cut their grass. Here we test whether 15-month-old toddlers can similarly judge whether shared action between two agents is imitative in one context but instrumental in another context.

Across two different violation-of-expectation looking-time tasks (Figure 1) conducted on different days over Zoom, the very same 15-month-old toddlers (N = 47, mean age = 14.89 months, range = 14.50 months – 15.49 months; 22 girls) saw simple shapes without eyes or limbs undertaking simple actions in a grid world. An equal number of toddlers participated in each task first, and data collection stopped when 32 toddlers met the inclusion criteria for each task. During familiarization in the Imitation Task,

one agent performed the same simple action as one of two other agents. During familiarization in the Instrumental Task, one agent also performed the same action as one of two other agents, but the first agent's action was efficient navigation to an object, which changed color upon contact. At test in both tasks, the first agent either approached the agent with whom it shared an action (same action/expected outcome) or approached the agent with whom it did not share an action (different action/unexpected outcome). If young toddlers think that someone is more likely to affiliate with another whom they acted like, then toddlers should look longer to the different action/unexpected outcome. If toddlers' predictions are specific to social contexts in which someone's actions are imitative, then toddlers should only show this pattern of looking in the Imitation Task.

Using mixed-model linear regressions, we found that toddlers looked significantly longer to the different action/unexpected outcome in the Imitation Task (Figure 2; Wald Test, $F(1, 31) = 12.74$, $p = .001$), but not in the Instrumental Task (Wald Test, $F(1, 31) = 0.14$, $p = .713$). We also found a significant interaction between task and outcome (Wald Test, $F(1, 82) = 4.50$, $p = .037$). These results suggest that young toddlers see the very same shared action between agents as imitative and social in one context or instrumental and not social in another context. From at least early toddlerhood, we may have highly abstract notions of others as either potential social partners whose actions are purely social or as rational and efficient agents whose actions are goal-directed towards objects.

These results raise at least two questions for future research: Can young toddlers see actions as simultaneously social and instrumental? How do our concepts of people, either as social partners or as agents, relate to our morality judgements? Building human-like social artificial intelligence will require answers to both if machines are to treat us as we treat others.

P3-G-585 - Maternal mental state talk versus connected talk: What helps children's theory of mind?

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Details

Background

Our study was motivated the following finding:

Although maternal mental state (MS) talk has been argued to facilitate children's theory of mind (ToM) (Ruffman et al., 2002), Ensor and Hughes (2008) argued it was connected talk that was paramount. They examined maternal MS talk as well as non-MS talk in three kinds of utterances: connected (parent-child conversations that continue on the same semantic theme), failed (one partner fails to elicit a semantically connected response), or initiation (speaker begins a new topic unrelated to the interlocuter's prior topic and successfully elicits a semantically-related response). They found that both connected communications without MS talk, and connected turns with MS talk, related to children's later ToM, arguing that maternal *connected* talk might be key rather than maternal MS talk. However,

there is a confound; talk is only connected if the child responds in a semantically related way. Yet such children are bound to have better language that enables ongoing conversation, and language is a reliable correlate of ToM (Milligan et al., 2007). Therefore, Ensor and Hughes' finding might simply indicate that children with better language end up with a better ToM, already a well established finding.

Aims

We had two aims:

1. Examine whether connected talk (sum of MS and non-MS) was the main correlate of children's later ToM as in Ensor and Hughes.

2. Examine whether maternal MS talk in *any utterance*, even a non-connected (failed) utterance, might be beneficial to children's ToM.

Method

1. At Time 1 (T1), we videoed interactions between 48 mother-child pairs (children aged 18 to 26 months) in free play, peek-a-boo and blocks scenarios, coding each mother utterance as (a) *connected*, *initiated* or *failed* and (b) and maternal MS talk (about desires, emotions or cognitions) or non-MS talk (talk not about mental states). We did this in both an in-person face-to-face format and a Zoom format.

2. Excellent inter-rater reliability (kappas .85 - .97).

3. At Time 2 (T2), 6 months later, we measured child MS vocabulary again.

Results

Figure 1 presents the number of maternal utterances of each type.

Finding 1

Unlike Ensor and Hughes, total connected talk (MS + non-MS) was not a significant correlate of children's later MS vocabulary, r=.097, and nor was total failed talk, r=.133, or total initiated talk, r=*.058.*

Back to top

Finding 2

The only T1 correlates of children's T2 MS vocabulary were (a) maternal connected MS talk (r=. 310, p<.05) and maternal failed MS talk (r=.336, p<.05).

However, in a regression, only T1 mother MS talk in *failed* utterances predicted children's T2 MS vocabulary, p=.011, independent of children's (a) age and (b) T1 vocabulary.

Conclusions:

1. Contrary to Ensor and Hughes (2008), maternal connected talk was not a correlate of later child ToM. Instead, maternal MS talk in failed utterances was beneficial to the child's later ToM independent of the child's age and earlier vocabulary.

2. Although it might seem that failed talk is unhelpful to children because the child doesn't respond, this study provides clear evidence that they benefit.

P3-G-586 - It takes a village: Examining the number of caregivers and how they support parenting and affect infant stress

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Details

Raising a baby is said to be so challenging that "it takes a village," but some family systems function with one caregiver while others function with many. An increase in multigenerational, LGBTQ+, single-parent, divorced and/or remarried, and multiple families has been seen and these diverse family systems require study into how it affects childrearing (Parke, 2013). But how does the number of caregivers involved in an infant's life affect things like parent stress and distress and reactivity of the infant? Perceived social support by a new mom was found to be essential for reducing fatigue and symptoms of postpartum depression (Iwata, Mori, Sakajo, Aoki, Maehara & Tamakoshi, 2018). The Parental Stress Scale (PSS) is being used to measure caregiver stress, the Infant Behavior Questionnaire-Revised Short Form (IBQ-R SF) and its subscales (distress to limitations and falling reactivity) are being used to measure infant stress, and The Brief Social Support Scale (BS6) will be used to measure perceived social support. The general purposes of this study are a) to examine the relationship between the number of caregivers and infant stress, to explore whether caregiver stress mediates that relationship, and b) to investigate the effect that social support plays in the association between the number of caregivers and caregiver stress. Data collection is ongoing and expected to conclude by February 2024, with an estimated final sample size of 130 family systems. Multiple regression will be performed in SPSS and PROCESS where mediation will be analyzed through indirect effects and moderation through interactions, see Figure 1. We hypothesize that the direct relationship between the number of caregivers and infant stress is mediated by caregiver stress, such that fewer caregivers involved in a family system is related to

increased caregiver stress and subsequent elevated infant distress and reactivity. We also hypothesize that the relationship between the number of caregivers and caregiver stress will be moderated by social support whereby the indirect effect of many caregivers resulting in lower caregiver stress is only present for family systems with high perceived social support. Support for these hypotheses would indicate that there might not be an ideal number of caregivers involved in raising an infant. A scatter plot matrix with the variables of interest has been included in Figure 2. It is important to note that data collection is in very early stages (current N = 7), so inferential statistics would be premature at this point. However, we will note that the associations between the number of caregivers and parental stress and the number of caregivers and falling reactivity are in the expected direction. The nuclear family model can be harmful as it delegitimizes completely acceptable models of what a family can look like (Cutas & Chan, 2012). The results of this study have the potential to elucidate the complex relationship between caregiver number and infant distress and reactivity, as well as emphasize the importance of family function over form.

P3-G-587 - The importance of prenatal maternal sleep: Infant brain connectivity as related to the hippocampus

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Details

Sleep is a universal and fundamental aspect of human health, including and especially in the prenatal period. Many pregnant people report not having adequate sleep during their pregnancy, and this poor prenatal sleep is in turn linked to increased risk for offspring neurodevelopmental disorders. Rodent studies have highlighted this association between poor prenatal sleep and infant brain development. Previous human work has shown that poor prenatal sleep problems are associated to increase in sleep problems for the following generation and ADHD symptoms. In addition, a link has been demonstrated between poor prenatal sleep and changes in infant offspring in hippocampal brain volume but no studies have examined hippocampal connectivity.

Our sample consisted of 42 mother-infant dyads (29 males) part of the NIH Environmental Influence on Child Health Outcomes Boricua Youth Study, a two-generation epidemiological cohort of Puerto Rican families. Sleeping infants underwent rsfMRI scans at average PMA 46.6 (range 36-63) in weeks on 3T GE scanners. fMRI analyses were implemented using SPM12[1] and CONN[2]. Pregnant participants completed the Pittsburgh Sleep Quality Index (PSQI), providing insight about their sleep quality, latency, and duration in pregnancy. Images were slice time and motion-corrected, coregistered with the anatomical scan, indirectly segmented[3] into gray matter, white matter, and CSR, normalized to an infant template brain[4], resampled (at 2mm isometric voxel), smoothed, and band-pass filtered (0.008–0.09 Hz). Correlation of the resting-state BOLD time series was computed using the bilateral hippocampal ROIs. Analyses controlled for infant's postmenstrual age at scan. Statistical comparisons will be controlled for using the false discovery rate.

Longer prenatal maternal sleep duration was associated with decreased negative connectivity between the R hippocampus and two clusters covering regions of the cerebellum crus 1 (*p*fdr=0.004) and the precuneus (*p*fdr=0.006). Duration was also associated with decreased connectivity between the L hippocampus and two clusters in the lateral occipital cortex (*p*fdr=0.0046; *p*fdr=0.00016). Total nighttime sleep duration was also associated with increased positive connectivity between the L hippocampus and a cluster covering regions of the L cuneal cortex (*p*fdr=0.0046). Increased sleep latency was associated with increased positive connectivity between the L hippocampus and a cluster covering regions of the R lateral occipital cortex, occipital fusiform gyrus, and cerebellum Crus 1 (*p*fdr=0.035). No associations were detected with R hippocampus connectivity. Prenatal maternal sleep quality was not associated to infant brain connectivity.

Our study is in line with previous research showing associations between sleep cycles and hippocampus-cerebellar connectivity (Benarroch, 2023). For example, rodent models have showed local field potential oscillations as coordinated between the hippocampus and cerebellum, suggesting a role for hippocampal-cerebellum connectivity in sleep/wake cycles. Findings here support previous work surrounding the importance of prenatal sleep, as poor sleep last 2 trimesters are found to be associated with increased risk of neurodevelopmental disorders and sleep problems in early childhood (Lugo-Candelas, 2023). Studies need to further understand the possible role of hippocampal-cerebellum connectivity on offspring sleep problems, leverage larger samples, and examine interactions with offspring sex.

P3-G-588 - Understanding the downstream effects of early sleep for vocabulary, academic achievement mental health in the Avon Longitudinal Study of Parents and Children and Born in Bradford longitudinal samples

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Details

Sleep in the early years is a dynamic process characterised by a period of transition in which daytime sleep reduces and gradually consolidates into nighttime sleep. A considerable percentage of infants under five years of age have difficulties with sleep (10-29%) (Byars et al., 2013; Williamson et al., 2019), and these sleep problems are negatively associated with multiple aspects of children's cognition (Sadeh, 2007), school performance (Dewald et al., 2010), and mental health (Wang et al., 2016). Despite this evidence, longitudinal research examining whether early sleep difficulties persist across development and predict later outcomes remains scarce. Our research aims to assess the stability of sleep over development via secondary data analysis of the Avon Longitudinal Study of Parents and Children. In this sample, sleep characteristics were assessed through questionnaires filled by the mother from 6 months (N=11485) to 9 years (N=7882) and by adolescents at 15 years (N=5515). Preliminary results from exploratory factor analyses at each time point in the first half of the dataset suggest that sleep characteristics (sleep routine, bedtime/wakeup time, number of night awakenings and sleep behaviours) load into two separate factors - the first capturing sleep quality behaviours and the second pertaining to aspects of the sleep routine. These observations were cross-validated in the second half of the dataset. Next, in line with our preregistation (https://osf.io/er5fz), longitudinal measurement invariance will be assessed before fitting a growth mixture model, which will clarify whether these aspects of sleep are stable across development

and predictive of later sleep. We will then examine whether sleep trajectories are predictive of vocabulary, academic achievement, and mental health across childhood and adolescence.

P3-G-589 - Examining self-regulation trajectories in at-risk infants across a parent-mediated telepractice intervention

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Details

Introduction: Self-regulation is a critical component of early development and explains the variation among infants and their adaptive capabilities within a constantly changing environment. Optimal self-regulation development in early childhood is pivotal for later developmental trajectories. Infants have limited capacity for self-regulation and often rely on their caregivers to demonstrate and modulate self-regulatory skills. Regardless of the developmental stage, in contexts where infants cannot properly self-regulate, co-regulation is commonly demonstrated and facilitated by the caregiver. Numerous studies have also examined the trajectory of self-regulation in young children. Overall, early childhood is a critical period where behavioral self-regulation is both acquired and refined; however less is known about regulatory behaviors in infants with at-risk development.

Objective: The purpose of the study was to investigate changes in self-regulation trajectories of infants at developmental risk across a 16-week parent-mediated telepractice intervention, examining parental control and its effects on child self-regulation skills.

Methods: The study recruited young children between the ages of 12-48 months with, or at-risk for, ASD (*n*= 6). The sample was randomly selected into two groups: (1) parent-mediated intervention; and (2) parent-mediated intervention and annotated feedback on home play intervention videos. Caregivers completed an assessment battery, including several social-emotional parent-report assessments of child's self-regulation including the *Brief Infant-Toddler Social Emotional Assessment*, the *Social-Emotional Assessment & Evaluation Measure* and the *Early Social Communication Scales*. Across the intervention children participated in three assessment sessions, including two observational self-regulation tasks: Snack Delay and Locked Box. Tasks were designed to assess self-regulatory, arousal, and emotion regulation behaviors. For a description of the parent-report measures and observational tasks see Table 1.

Results: Repeated measures ANOVA results showed no significant differences between groups but associations between negative parental control and self-regulation from pre-intervention to post-intervention decreased (M = 2.00, SD = 1.00; M = 2.33, SD = 1.154; M = 1.667, SD = 1.154; M = 2.00, SD = 1.000). One-way ANOVA results of the BITSEA were statistically significant at pre-intervention ($F(1,4) = 9.191$, $p = .039$). The SEAM and ESCS trends demonstrated increases across all time points. Results from simple linear regression showed significant results in the locked-box task at both pre-intervention and post-intervention ($R^2 = .356$, $F(1, 5) = .552$, $p > .05$).

Conclusions: Explicating the relationship between maternal control and self-regulation is essential for understanding how parenting practices may influence the development of children's ability to manage their emotions, behavior, and cognitive processes. These findings demonstrate that targeting joint attention throughout the intervention positively impacts at risk children's self-regulatory abilities. By examining maternal parenting practices within the context of negative control and focusing on emphasizing positive play interactions, these results further demonstrate the significance of maternal influences on joint attention and self-regulation skills. These results demonstrate the critical role that joint attention and self-regulation play in mediating cognitive processes, as well as highlighting the pivotal role parent mediated interventions determine in boosting children's developmental trajectories.

P3-G-590 - Baby biology, toddler temperament, and child inhibitory control: Direct and indirect associations

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Details

Inhibitory/self-control (ISC) is important for predicting socioemotional and psychological developmental outcomes (Shonkoff & Phillips, 2000). Children are capable of ISC in early childhood and there are early life psychobiological
precursors that predict individual abilities in such. For example, physiological factors like left electroencephalogram frontal asymmetry (EEG FA) and higher baseline respiratory sinus arrhythmia (RSA) have been associated with better
ISC in childhood (Fox et al., 2001; Porges, 2007). Further, temperamental measures, like high effortful control and low surgency, are associated with better child ISC (Gagne, 2017). Although these independent associations among ISC and
physiology and temperament are apparent, research has not thoroughly examined the longitudinal direct and indirect associations between early psychobiological factors and ISC, thus the goal of our current study.

Participants included 410 mother-child dyads who visited the lab when children were 10-, 24-, and 36-months old. At 10-months, infant EEG FA and RSA were recorded during a 2-minute baseline period. At 24-months, mothers reported on
toddler surgency and effortful control using the Early Childhood Behavior Questionnaire (Putnam et al., 2006). At 36-months, mothers reported on child ISC using the inhibitory/self-control index of the Behavior Rating Inventory of
Executive Function- Preschool Version (Gioia et al., 2000), where higher scores indicate poorer ISC. We used path modeling in Mplus (Muthen & Muthen, 2017) to examine our research question. Specifically, we regressed ISC onto surgency
and effortful control and surgency and effortful control were regressed onto EEG FA and RSA. We also tested indirect effects from both infant EEG FA and RSA to early childhood ISC through toddler temperament. Our model, shown in Figure
1, achieved acceptable fit (RMSEA = .000, SRMR = .024, CFI = 1.000). As depicted in Table 1, EEG FA indirectly predicted ISC through effortful control and RSA indirectly predicted ISC through surgency.

Specifically, more left EEG FA
directly predicted less effortful control, less effortful control directly predicted poorer ISC, and more left EEG FA indirectly predicted poorer ISC. Additionally, higher baseline RSA directly predicted more surgency and indirectly
predicted poorer ISC.

Overall, our results demonstrate that early life biopsychological factors are important precursors for early childhood ISC. Although our data demonstrated that EEG FA and RSA indirectly predict ISC in the opposite directions from what
prior work has suggested (Fox et al., 2001; Porges, 2007), it is possible that when considered with temperament, biological factors may be subject to differential susceptibility (Belsky, 2007) in how they predict ISC. In other words,
perhaps children who exhibit better biological regulation during infancy are more susceptible to developing poorer ISC when they also have less adaptive temperament traits like low effortful control and high surgency in toddlerhood.
Additionally, left EEG FA and high baseline RSA are associated with more approach-type behaviors (Fortunato et al., 2015; Palmiero & Piccardi, 2017), which could explain their indirect influences on ISC through temperament. More
research on these ideas is warranted, particularly in examining factors that might influence temperament development in toddlerhood, but our study serves as an important first step.

(R01 HD049878)

P3-G-591 - Latent profile analysis of maternal mental health in an at-risk sample: Influence on infant outcomes

Jesseca Perlman [1], **Samantha Burns** [1], **Esther Yu** [1], **Michal Perlman** [1]

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Details

The cognitive, social, and emotional development of a child is heavily influenced by their mother's mental well-being during pregnancy and the initial year postpartum (Goodman, 2019). Infant temperament challenges, such as heightened reactivity (e.g., fear, anger) and activity levels, have been linked to an elevated risk of future internalizing and externalizing disorders (Shaw et al., 2001). However, there is limited research on how these relationships exist in vulnerable and diverse populations. Therefore, the purpose of this study is to (1) identify subgroups of low socioeconomic and diverse mothers based on their mental health; (2) examine the relationship between mental health profiles and demographic variables (i.e., income, maternal education, maternal ethnicity); and (3) assess the relationship between mental health profiles and infant temperament, internalizing and externalizing behaviors, and cognitive development. Our study consisted of 520 mothers and their infants. Notably, nearly half of the participants were single mothers with significantly low household incomes ($29,482.53 compared to the average for families with young children of $104,378.00; City of Toronto, 2018). We conducted latent profile analysis (LPA) to identify unique mental health profiles, accounting for

demographic variables. LPA yielded three latent profiles (see Table 1): good mental health (lower psychopathology), moderate mental health (moderate psychopathology), and impaired mental health (high psychopathology; see Figure 1). Demographic variables did not impact group allocation, although income approached significance (p = .07). There was a significant difference in infant fear between good (M = 2.64, SD = 1.41) and moderate mental health profiles (M = 3.04, SD = 1.46; p = .05), but not anger. Further analysis will be conducted to assess the relation between maternal mental health during their child's infancy on later children's mental health, communicative development, and vocabulary.

P3-G-592 - Examining the association between functional connectivity and regulatory behavior in 5- to 7-month-old infants

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Details

The first years of life are a critical time for brain development, with most higher-order brain networks establishing adultlike connectivity by the end of the second year of life (Gao et al., 2013). Individual differences in functional connectivity have been linked to affective, cognitive, and behavioral outcomes across the lifespan (Friston, 2011), and there is evidence that these differences can be used as an early biomarker of neurodevelopmental disorders (Hu et al., 2020). Additionally, infant and child temperament is another early-emerging, biologically based factor that is predictive of long-term affective and behavioral outcomes (Caspi et al., 1996), and is known to be associated with differences in functional connectivity. For example, adults with low regulatory functioning were found to have decreased connectivity in the fronto-parietal network (FPN), a network related to cognitive control, and increased connectivity in the default mode network (DMN), a network involved in self-oriented thought (Bjørnebekk et al., 2013, Kaiser et al., 2015). Similar brain-behavior association effects were recently reported in a sample of newborn infants (Kelsey et al., 2021) suggesting the early developmental emergence of these functional brain networks. The current study continued to follow this sample of newborn infants further into the first year of postnatal development. Specifically, the present study examined the relation between resting-state functional connectivity in the FPN and DMN and infants' regulatory behavior at both 5 and 7 months of age. Participants were part of a large longitudinal study of 121 mother-infant dyads, with 109 dyads completing the 5-month visit and 97 dyads completing the 7-month visit. At both timepoints, resting-state functional connectivity data were collected from awake infants using functional near-infrared spectroscopy (fNIRS), and network connectivity scores for the FPN and DMN were created for each infant. Infants' regulatory behavior was assessed via parent report using the Infant Behavior Questionnaire Revised Short form (IBQ-R-Short, Putnam et al., 2014), and infants' regulation/orienting behavior scores were calculated for each timepoint. Based on previous findings from this sample, we hypothesized that infants' regulation/orienting behavior scores would be positively associated with connectivity levels in the FPN and negatively associated with connectivity levels in the DMN, and we used separate multiple linear regression analyses for the 5-month and 7-month timepoints to test our hypotheses. Contrary to our predictions, we did not find the same pattern of associations between functional connectivity and regulatory behaviors that have been observed previously. Instead, we found that there were no significant associations between infants' regulatory behavior and their functional connectivity levels in either network at 5 months, while at 7 months

infants' regulation/orienting behavior scores were negatively associated with connectivity in the FPN (*n* = 18, *B* = -.498, *p* = .042) and positively associated with connectivity in the DMN (*n* = 18, *B* = .770, *p* = .004). These results highlight the rapidly changing nature of infants' developing functional brain networks and underscores the need for researchers to examine multiple developmental timepoints to better understand the emerging associations between brain function and behavior during infancy.

P3-G-593 - Parental mind-mindedness and child executive functions during toddlerhood: A biparental and longitudinal study

Julien Massicotte [1], **Charles-Anthony Dubeau** [2], **Frederic Theriault Couture** [2], **Marie-Ève Lajeunesse** [2], **Célia Matte-Gagné** [2]

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Details

Executive functions (EF) are higher cognitive processes involved in the voluntary control of thoughts, emotions, and actions, which include inhibitory control, working memory, and cognitive flexibility (Diamond, 2013). These cognitive skills are crucial for children's optimal functioning in several spheres (Zelazo et al., 2016). Therefore, understanding the factors involved in their development is of paramount importance. Previous research indicates that parental mind-mindedness (MM; i.e., the capacity to interpret the child's mental states adequately) is associated with positive child outcomes, including better EF (Aldrich, 2021). However, the distinct contribution of fathers' and mothers' MM in the emergence of children's EF during toddlerhood remains unknown. The present longitudinal study aimed to rectify this by examining the unique role of fathers' and mothers' MM during infancy in predicting toddlers' EF. The sample includes 169 children met at home with their parents at 6 (T1) and 19 (T2) months of age. At T1, both parents' MM were rated, based on a 10-minute parent-infant free play period, using a widely recognized and validated coding system (Meins & Fernyhough, 2015). Parental MM was assessed using the number of attuned and unattuned comments on the child's mental states (emotions, thoughts, needs, and desires) during a parent-child free play session. At T2, EF were measured using three tasks. In the first task, called "Prohibition" (inhibitory control, Friedman et al., 2011), the child must refrain from touching a prohibited toy for 30 seconds (scores = latency before touching the toy). In the second task, named "Hide and Seek" (working memory; Johansson et al., 2016), the child must locate a toy hidden beneath one of three opaque glasses (scores ranging from 1 to 3). During the last task, called "Reverse Categorization" (cognitive flexibility; Johansson et al., 2016), the child is instructed to sort a set of blocks according to a changing rule (scores ranging from 0 to 5). Descriptive statistics and

correlations are displayed in Table 1. Regressions were carried out to predict all three components of toddlers' EF (see Table 2). Mothers' unattuned comments negatively predicted toddlers' inhibitory control (b = -.26, p = .02), working memory (b = -.27, p = .02), and cognitive flexibility (b = -.28, p = .01), whereas their attuned comments positively predicted cognitive flexibility (b = .30, p = .01). Fathers' MM comments at T1, whether attuned or unattuned, were not predictive of any of the EF components. Findings support the importance of maternal MM for the early development of child EF. This study provides novel insights into how maternal attuned and unattuned comments on children's mental states are distinctly related to child EF in toddlerhood. However, future research is needed to better

understand the mechanisms behind these differential links. Results will be discussed in light of the relevant literature and implications for research and practice will be considered.

P3-G-594 - Maternal cortisol and infant crying: An examination of mother-infant endocrine dynamics

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Details

The stress response system has evolved as a foundational survival mechanism. Cortisol is a biomarker of stress reactivity. When adults and children feel uncomfortable or anxious (e.g., hungry, cold, tired, afraid), the hypothalamic-pituitary-adrenal (HPA) axis activates and releases cortisol into the blood approximately 20–30 minutes after the stressful event. Infants often respond to stressful situations by crying. Infants' crying can provide a cue to caregivers that the infant is uncomfortable or anxious, eliciting responses from the mother and other caregivers (Bornstein et al. 2017, Yoo et al. 2018).

Previous psychophysiological experiments have revealed that infants' crying can elicit negative emotions in adults, independent of parenting experience, causing an increase in cortisol levels (Fleming et al. 2002, Giardino et al. 2008, Out et al. 2010).

Interestingly, although mothers are known to exhibit behavioral responses to soothe crying infants, it is unclear whether they also exhibit physiological responses to infant crying, such as increased cortisol levels. If mothers experience negative emotional responses to their infant crying, like other adults, this may be reflected in maternal cortisol levels. Alternatively, if mothers, who are familiar with their infants' cries, do not perceive it as particularly stressful, their cortisol levels may not increase.

In the present study, we measured salivary cortisol changes in mothers and infants when the infant experienced short-term maternal separation, in a modified "strange situation" procedure (Ainsworth et al. 1978). Salivary cortisol before and after separation was quantified using an ELISA kit (Salimetrics). Fifty-three pairs of 10-month-old infants and their mothers were examined. During the maternal separation, 21 infants cried, and 32 did not. The cortisol changes in all infants and their mothers were measured before and after separation. When infants cried, their cortisol levels increased significantly. However, mothers' cortisol levels did not increase; instead, mothers' cortisol levels decreased regardless of infant crying. Furthermore, the results revealed a significant correlation between changes in cortisol levels in mothers and daily mothering stress as measured by a questionnaire.
We found that infants' crying, which generally evokes negative emotions in adults, did not affect maternal cortisol levels. The present results are in accord with the following three possibilities: 1) Habituation or prediction: mothers may have had sufficient information about the experiment and enough time to become familiar with the experimental situation, easing their nervousness and anxiety as the experiment progressed; 2) Suppression of HPA activity: because mothers were more focused on comforting their child regardless of whether the infant was crying or not, HPA axis activity may have been suppressed, causing cortisol to decrease; 3) Specific responses to parenting stress in HPA: HPA responds specifically to stress experienced by the self. Mothers may not feel discomfort when their infants cry, although daily parenting stress affects HPA activation. Further studies will be needed to

determine which of these scenarios best explains the current results, using other physiological markers such as oxytocin, or comparison between mothers.

P3-G-595 - Exposure to media in infants and its relation to maternal education

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Details

The WHO (2019) recommends no media exposure in infants and no more than 30 minutes per day in three year old children. Studies indicate a negative impact on maternal bonding and the child's regulatory ability even with passive media use in the background. Mothers use media for various reasons, such as dealing with difficult behaviors of the child or promoting educational development. The Bremen Initiative to Foster Early Childhood Development (BRISE) is a longitudinal, interventional study working with families from underprivileged areas of the mid-size town Bremen, Germany. In this analysis, maternal report data of the 1st and 2nd wave (N = 300) at the infants age of 7 months (T2) and 13 months (T3) was included. Data comprised information on the extent of media use for different devices, active vs. passive background use, as well as intentions of use. ISCED 11 was utilized to reflect maternal education.
Media use with infants was reported by 79.0% of the mothers at T2 and 85.6% at T3. Regarding daily media use, background television was reported most frequently, in total from 61.8% of the mothers at T2 and 72.2% at T3. It, thereby, exceeded 30 minutes per day in approximately half of the household at both time points.
Intention for media use comprised educational purposes (T2: 18.6%, T3: 33.8%), needing time for something else (T2: 25.8%, T3: 37.8%) or time to relax (T2: 14.2%, T3: 25.9%), keeping the baby occupied (T2: 21.4%, T3: 36.6%) or calming the baby (T2: 19.3%, T3: 33.5%). Some mothers stated that they did not have their children within sight (T2: 24.0 %, T3: 20.5 %), hearing distance (T2: 23.4 %, T3: 22.6 %) or in the same room (T2: 22.0 %, T3: 15.4 %) when they exposed their children to media.
Correlations indicated that the duration and frequency of media use at T2 is positively associated with its corresponding measures at T3 ($p<0.5$). Longer duration and higher frequency of media exposure at T3 further correlates with a low level of maternal education ($p=.01$).
The results indicate that over 85% of the infants in this sample of socially and/or culturally challenged families were regularly exposed to media, even though no media use is recommended at that age. Media exposure even exceeded 30 minutes per day in at least half of the households, which reflects the recommended limit for three-year-olds. The intentions for media use are multifold, indicating challenges in daily childcare and need for better information on how to support educational development. Preventive measures should take into account particular family constellations and challenges, as reflected in this study by maternal education levels.

P3-G-596 - "The survival rate of the cookies" Studying the role of age and family background for inhibitory control in young toddlers

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Details

Toddlers often struggle with situations that require inhibitory control. Longitudinal studies reveal that performance at two- to three years of age predicts later life success. Using a delay of gratification task, Watts, Duncan & Quan (2018) found that toddlers who waited at least 30 seconds before grabbing the reward had better long-term outcomes than those who couldn't. Based on this finding, we assume that children's ability to refrain from following their first impulse undergoes substantial development between two and three years of age, and that developmental changes or other group differences can best be assessed when considering children's ability to inhibit their impulse for the first 30 seconds.

A total of 165 children from mostly privileged families with a higher income and educational background (22-months-olds: 47; 24-month-olds: 62; 26-month-olds: 56; gender balanced), as well as a sample of 300 toddlers from underprivileged families (low income, low educational, and/or migration background) who participate in a larger panel study (BRISE), ranging between 23 and 34 months of age took part in the same waiting task: All children were instructed to refrain from touching cookies placed in a bowl within reach, before the experimenter removed a cover to make them visible to the child, and then left the room for two minutes. The caregiver stayed in the background, pretended to read a magazine, and was instructed not to talk to the child.

The duration of waiting time until the first cookie touched the lips of the child was measured via stop watch from video. Based on this measure, the "survival rate of the cookies" was calculated, reflecting the percentage of children who refrained from eating a cookie at any given time during the waiting period. So far, the data of the privileged sample, and the data from n = 70 children of the underprivileged sample have been coded and analyzed.

In the privileged sample, 30% of the 22-month-olds, 41% of the 24-month-olds, and 73% of the 26-month-olds managed to wait at least 30 seconds, with survival curves starting to diverge at around 10 seconds (see Figure 1). The mean waiting time increased linearly and significantly from M = 27,66 seconds (SD = 37,77) at 22 months, to M = 79,63 seconds (SD = 51,37) at 26 months. Consistent with Watts Duncan, and Quan (2018), age-differences were evident after 30 seconds waiting time already, and did not change much thereafter. In addition, N = 70 valid cases from the underprivileged sample (mean age: 27;6 months, range: 23-34 months) revealed a mean waiting time of M = 66,55 seconds, thus reaching lower scores than even for the oldest group of the other sample. Data coding and analysis for the remaining cases is still under way.

Together, these results indicate that inhibitory control undergoes substantial developmental changes during toddlerhood, but also varies largely between individuals. Whether family background plays a role in this context will be tested. Survival-rate analysis provides a valid and highly useful marker of group differences in inhibitory control.

P3-G-597 - The development of semantic priming : a computational model

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Back to top

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Details

We propose a simple computational model that describes potential mechanisms underlying the organization and development of the lexical-semantic system from 15 to 18-month-old infants. Our model is an extension of Mayor and Plunkett (2010)'s model of taxonomic responding. Similarly to (Plaut & Booth, 2000) it explains taxonomic priming between words by semantic feature overlap, whereas associative priming between words is explained by Hebbian links between semantic representations derived from co-occurrence relations between words (or their referents). Differently from (Plaut & Booth, 2000) though, here feature overlap is an emergent process, and taxonomic priming derives from this process. The model successfully replicates infant data on the development of semantic priming (Delle Luche, Durrant, Floccia, & Plunkett, 2014; Floccia, Delle Luche, Hills, & Plunkett, 2016; Plunkett, Delle Luche, Hills, & Floccia, 2022). Delle Luche et al. (2014) demonstrated that 18 months olds listen longer to lists of words coming from the same taxonomic category (e.g., "dog, pig, cat, sheep, . . . ") than to lists of words coming from different categories (e.g., "nappy, boots, tummy, mouth, sock, . . . "). On the contrary, preliminary results by Floccia et al. (2016) showed that younger infants of 15 months do not exhibit longer looking times for taxonomically related lists of words, compared to unrelated lists. This suggests that at 15 months taxonomic relations might not yet be in place in the infant lexicon. 15 months old do however appreciate relations between words that are both taxonomically and associatively related, suggesting that associative links might develop before taxonomic links. Our model describes in a mechanistic way how taxonomic and associative links might develop with this schedule. The model is an extension of Mayor and Plunkett's (2010) model of early word learning. As in Mayor and Plunkett's (2010) model, our model contains two sub-networks which are self-organising maps (Kohonen, 2001): an auditory map 1 and a conceptual map, linked by Hebbian connections. With respect to Mayor and Plunkett's (2010) model, here we introduce two novel elements. First, we introduce a distinction between basic semantic features and extra features that can be learned at different moments. Second, we introduce relations between associatively-related semantic representations. These relations are implemented by Hebbian links between the conceptual map's units. In the model, taxonomic and associative relations develop by following the schedule described by the experimental data. The model successfully mimicks infants' looking time

P3-G-598 - Neural bases of food categorization in adults and 12-month-old infants using a fast periodic visual stimulation paradigm

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Details

Human adults are extremely skilled at detecting foods among other entities in their environment. The adult brain selectively and rapidly discriminates between foods and inedible stimuli in the ventral visual cortex (Khosla et al., 2022; Tsourides et al., 2016), similar to the brain response for faces (Kanwisher et al., 1997). Yet, how and when humans acquire this capacity is largely unknown. One of the few behavioral

studies investigating how infants identify foods and generalize properties did not find signature characteristics of food perception observed in children and adults, but broad categorization of foods was not tested (Shutts et al., 2009). Moreover, infants' food cognition might be richer than previously thought. Recent research found that 6-month-olds learn differently from actions depending on whether they are performed on inedible objects or on objects that could be foods (e.g., Wertz & Wynn, 2014). These data imply that some capacity to discriminate edible from non-edible objects emerges from an early age, but it is still not clear at what age and what are the neural bases of this capacity.

To address these issues, we employed the Fast Periodic Visual Stimulation paradigm (FPVS) with food stimuli to study the development and neural bases of food categorization. The FPVS was developed to obtain an objective neural index of categorization and has been well-validated with adults and infants notably to study face processing (e.g. de Heering & Rossion, 2015) but to our knowledge, it has not been used to test food categorization.

In our paradigm, participants saw sequences of visual stimuli from distractor categories (e.g., non-foods like natural kinds or artifacts depending on conditions), interspersed every five images with a stimulus from a target category (AAAABAAAAB…, e.g., a food item, Fig. 1). Images were presented at a rapid rate of 6Hz (6 images/second), and the target category presentation rate was 1.2Hz. Participants' responses were measured with the electroencephalogram (EEG) in the frequency domain. In a first type of sequence, stimuli were normal images of foods, natural kinds and artifacts. To control for low-level confounds, in a second type of sequence, the stimuli were transformed to contain the same low-level information as the original images while making their category unrecognizable (Fig.1).

The adult sample (N=25, 18-35y.) was tested to characterize a mature food categorization response, as FPVS has never been used with food stimuli. Our preliminary results showed that the signal was significantly higher than noise over the occipital area at the target category frequency (1st to 4th harmonics, all ps<.05) for sequences with normal images (Fig. 2a). In contrast, the response was not significantly higher than noise at the target category frequency for the 2nd to 4th harmonics for sequences with transformed images (Fig.2b). Data collection in 12-month-olds is ongoing, and data analysis is expected to be finished by July.

The study aims to contribute to the further development of methods such as FPVS to study conceptual development in infants and will provide the first investigation of the developmental course of food categorization in the human brain.

P3-G-599 - Are hands special in the first year of life? Neural categorization of hands in adults and 4-month-old infants as revealed by fast periodic visual stimulation

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Details

The early preference for looking at faces is well established (Mondloch et al., 1999; Turati et al., 2006) and neuroimaging studies revealed that infants' face perception depends on activity in specific regions

within the right ventral and lateral occipito-temporal cortex (Conte et al., 2020). In addition, the Fast Periodic Visual Stimulation (FPVS), a paradigm developed to obtain an objective index of neural categorization, allowed to demonstrate that infants' EEG activity differentiates between visual non-face objects presented at a rapid rate (i.e., 6 Hz) and face stimuli presented at a lower rate (i.e., 1.2 Hz), indicating a right-hemisphere categorization response for faces vs non-face objects at 4 months (de Heering & Rossion, 2015). Much less is known about infants' early visual preference and neural sensitivity for hands. Research demonstrated that hands are salient stimuli starting from the first months of life (von Hofsten, 2004), and that by 7-10 months infants begin to make sophisticated attributions about human hands (Biro & Leslie, 2007). Infants also show a preference for their hands in motion (van der Meer, 1997) and for biomechanically possible versus impossible hand movements (Longhi et al., 2015). From a neurophysiological perspective, 8-month-olds' right temporal cortex responds distinctly to human vs mechanical hands (Biondi et al., 2016), and the P400 event-related potential component was reported to be sensitive not only to the processing of faces (de Haan et al., 2002), but also to the observation of grasping hands in 6-month-old infants who are proficient at grasping (Bakker et al., 2015) and to the observation of congruent pointing between 6 and 8 months of age (Gredeback et al., 2010). The aim of the current study is to use a FPVS oddball paradigm coupled with EEG recording to investigate the neural discrimination of naturalistic hand images from other objects. The deviant/oddball stimulus (i.e., hand) was introduced in the sequence, creating categorical changes (i.e., hands vs objects) at a frequency of 1.2 Hz. To date, twelve 5-month-olds and thirty-four young adults have been tested and data collection is still ongoing for the infants sample. Preliminary results show that the signal was significantly higher than noise across bilateral occipital and parieto-occipital electrode clusters at the oddball frequency (2nd to 4th harmonics) in adults (all *p*s < .001). Additionally, amplitude was significantly higher than noise at the oddball frequency (4th harmonic) selectively over the medial occipital cluster ($p < .001$) in 5-month-olds. To track the neural development of hand categorization, data from an additional sample of 8-month-olds will be collected. This will allow us to investigate the role of experience in modulating the processing of hands by exploring the relation between infants' experience with manual actions (e.g., power or pincer grasps) and their ability to categorize hands. Findings from the current study will be discussed with respect to the use of FPVS as a valid measure for investigating the neural correlates of infants' ability to categorize hand stimuli across the first year of life and the potential role of sensorimotor experience in shaping this capability.

P3-G-600 - Where is the car I saw someone hide on screen? Infants' understanding of communication seen on video or on video-chat

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Details

Interactions via online communication platforms have become ubiquitous in the lives of children. In this study, we investigate how 18 months old infants reason about the consequences of events observed on a screen may have on off-screen settings.

Children play a warm-up game with an experimenter (E), during which a bear is hidden in one of two boxes. Once children select the correct location at least 3 times, the test phase starts. Children observe a

protagonist (P) first hiding a car and then a star in one of two boxes either in the room (Live), on a pre-recorded video (Video) or during an interaction via video chat (Video Chat). After each hiding event, children receive the boxes and their choice is recorded. We predict that more children would search in the indicated box the Live and the Video Chat conditions, compared to the Video condition.

We report data with 69 children. In the 1st trial, children search at the indicated location 78% and 48% of the time in the Video Chat, and the Video Conditions, respectively. This rate is 61% in the Live Condition. This pattern suggests that infants already at this age differentiate video and video chat conditions, based on their understanding of contingent interaction. However, it is difficult to interpret why in the live condition the choice pattern is not different from the other two conditions.

P3-G-601 - Longitudinal associations among variables associated with fairness

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Details

In the present research, we explore the formation and evolution of distributive justice concepts among young children, specifically examining the relationship between infants' expectations for justice and their actions in sharing as they mature into toddlers. This study is a continuation and expansion of prior research (e.g., Sloane et al., 2012; Ziv & Somerville, 2014), which has traced the development from an understanding of equality in 13-month-olds to a grasp of equity by the age of 21 months (Drew et al., in prep). Our focus is on the lasting impact of early anticipatory notions of fairness, both in terms of equality and equity, on children's later behaviors in allocating resources.

The investigation involved monitoring infants at the ages of 13 and 21 months using the Violation of Expectation (VoE) paradigms to measure their reactions—specifically, their gaze duration—to different scenarios showcasing either equal versus unequal (Schmidt & Somerville, 2011) or equitable versus inequitable resource distribution (Sloane et al., 2012). Additionally, by the age of two, we assessed the children's tendency to reward behaviors that differentiated between helpful and unhelpful characters (Hamlin & Wynn, 2011) and, at 3.5 years, their readiness to share resources, like stickers, with an absent peer (Gummerum et al., 2010).

The core of our findings from a recent group of 40 participants revealed that the initial reactions of infants to fair distributions—captured through their looking times—did not predict their future behaviors regarding the distribution of resources. Specifically, early attentiveness to acts of equality and equity was found to have a slight negative correlation with their distributive behaviors as they grew older (r = -0.13, *n.s*), indicating no significant predictive power for their eventual personal actions in resource distribution.

By delving into the nuanced understanding of distributive justice among infants and toddlers, our study aims to shed light on the cognitive and moral development processes that underpin the complex behaviors of sharing and fairness. Despite the anticipation that early reactions to fairness would serve as a foundation for later distributive actions, our results suggest a more intricate relationship that does not straightforwardly predict later behaviors from earlier expectations. This research not only contributes to the existing body of knowledge on child development and moral psychology but also opens new avenues for further exploration into how notions of fairness and justice evolve from infancy through toddlerhood.

P3-G-602 - Infants' moral trait inferences in multi-agent social interactions

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Details

Humans can rapidly use information from others' behaviours to inform their future decisions. We do this by making trait inferences: after seeing a snippet of a person's behaviour, humans can assign a trait based on that behaviour, and use that trait to predict that person's future behaviour. The ability to make trait inferences can be traced back to infancy. Infants suspend expectations for fairness if an agent previously hindered but not if that agent helped (Surian et al., 2018). Likewise, infants expect unfair distributors to hinder, but do not expect fair distributors to do the same (Gill & Sommerville, 2023). This ability to engage in behavioural predictions is rooted in the ability to make trait inferences (Kalish, 2002). Although research provides preliminary evidence that infants can infer traits, we do not know if this also applies to real-world social contexts with agents that can fall into ambiguous moral roles. In our research, we investigate infants' moral trait inferences towards agents in four separate roles: aggressors, protectors, bystanders, and victims. We predicted that infants would expect aggressors to be unfair and protectors to be fair, but we do not have directional predictions for bystanders and victims.

Using a violation-of-expectation paradigm, we familiarized infants (N=160) aged 12-24 months-old to a protective third-party intervention (PTPI) paradigm in which an aggressor hits and chases a victim before a protector intervenes to protect the victim, or a bystander watches from the side (Kanakogi et al., 2017; Figure 1). Depending on the condition (N=32 per condition), infants next saw two videos in which one of the agents distributed resources evenly and unevenly between two recipients. Infants looked longer when the aggressor distributed resources fairly ($t(31) = 2.45$, $p = .020$, $d = .43$; Figure 2), indicating that they expected the aggressor to be unfair. For the protector and the victim, infants looked longer towards the unfair test trial (Protector: $t(31) = 3.58$, $p = .001$, $d = .63$; Victim: $t(31) = 2.12$, $p = .042$, $d = .37$). There was no significant difference in looking time between fair and unfair for the bystander ($t(31) = .78$, $p = .44$, $d = .14$). We also included a baseline condition in which infants were familiarized with a random movement control. Infants looking time in the baseline condition did not significantly differ ($t(31) = 1.84$, $p = .076$, $d = .33$), but trended towards longer looking time towards unfair distributions, consistent with past research on infant's baseline expectations for fairness (Schmidt & Sommerville, 2011).

Overall, we demonstrate that infants expect aggressors to behave unfairly, protectors and victims to behave fairly, and they had equal expectations for fairness or unfairness for bystanders. These results provide further support that infants are able to make moral trait inferences. Furthermore, we demonstrate that infants can make trait inferences in social situations that contain at least three agents in active roles, and we provide evidence that infants are able to make moral trait inferences towards victims and bystanders, two previously understudied roles in infancy research.

P3-H-603 - Understanding the dynamics of child temperament, parental stress, and screen use in early childhood: Insights from a Swedish cohort

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Details

This study investigated the relationships between child temperament, parental stress, and screen use in a cohort of 158 children aged 14-33 months in Sweden. Sweden lacked official guidelines on screen use until recently, making it particularly interesting to examine the influence of child temperament and parental stress on screen usage by parents and their children. The aim of the study is to analyze the contribution of child temperament and parental stress on screen usage by parents and their young children. Recent research highlighted the mediating role of parental stress and child temperament in shaping child screen use behaviors. Parents, experiencing elevated stress levels, are observed to be more inclined to permit increased screen time for their children as a coping mechanism. Various facets of the child's temperament contribute to the child's use of screens, including a reactive subdimension encompassing negative affectivity and surgency —characterized by active engagement with the environment. Both dimensions have been linked to heightened screen media exposure. The final subdivision, Effortful control, emerges as pivotal in emotional regulation and behavioral inhibition, with low effortful control associated with increased screen use.

An online survey, distributed through social media and online parent groups, utilized measures the Early Childhood Behavior Questionnaire (ECBQ) for child temperament, the Parenting Stress Index (PSI) for parental stress, and the Media Activity Questionnaire (MAQ-2) for home media use. These collectively contribute to a comprehensive understanding of the dynamics under investigation.

Correlation analyses (Table 1) revealed a significant association between high parental stress and increased child and parental screen use. A significant interrelation was also observed between parent and child screen use. Specific aspects of the reactive subdimension, particularly surgency, were identified as linked to heightened parental stress. Children with lower effortful control were found to have more stressed parents, and highly stressed parents tended to have children with increased screen time. Increased screen time in children was associated with reduced sleep duration. As children age, screen time tends to increase.

In summary, this research sheds light on the intricate family dynamics involving parental stress, child temperament, and sleep patterns, all of which play a role in determining the extent of screen use by both parents and children. The findings contribute to our understanding of the complex interplay between psychological and behavioral factors influencing screen-related behaviors in early childhood. The results align with findings from countries with established screen use guidelines.

P3-H-604 - Developmental origins of infant brain responding to emotional experiences and events

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Details

Two important neural indicators of emotional processing are (1) frontal asymmetries in EEG brain activity at rest and when engaged in emotional events (Fox and Davidson, 1988) and (2) time-locked brain activity referred to as event-related potentials (ERPs) to the presentation of faces (Nelson & De Haan, 1996). Individual differences emerge in infancy and are implicated in infant (mal)adjustment (Fox et al., 2009; Smith & Bell, 2010). Thus, it is important to understand the developmental origins of these patterns of neural responding. In this study, we examined the significance of environmental (mother and father parenting) and endogenous (infant temperament) characteristics for emotion-related infant brain responding.

Parents and their infants (N = 69) participated in a longitudinal study. When the infants were 6 months, mothers and fathers were observed during caregiving tasks with their infant to assess sensitive responding. Infant temperamental approach (i.e., positive anticipation of events) and fear (i.e., inhibition to novelty) were reported by mothers using the Infant Behavior Questionnaire-Revised. At 12 months, infants' EEG was monitored during a standard 2-min baseline task, positive (2 min) and negative (2 min) emotion-eliciting tasks (i.e., happy and sad peek-a-boo game) with their mother and a stranger, and passive viewing of adult emotional facial expressions. A fast-Fourier transform was used to extract frontal EEG asymmetry in the alpha frequency band (6-9 Hz) at F3/F4 electrodes during the baseline and emotion-eliciting tasks. The Nc component is an ERP implicated in facial processing and was extracted from the time-locked EEG activity at C3/C4 electrodes to each emotional expression (happy, sad, neutral).

Correlation and regression analyses were conducted to examine whether parents' sensitivity and infant temperament were associated with infant emotion-related neural responding. Regarding temperament, fear was associated with right frontal asymmetry during baseline (r = -.27, p < .05). Controlling for baseline, infant temperamental approach was significantly associated with greater left frontal EEG during happy peek-a-boo with mothers (b = .18, p < .05). Findings indicated that higher levels of mother sensitivity at 6 months was associated with infant's greater right frontal asymmetry during the sad peek-a-boo with a stranger (b = -.21, p < .05). Regarding infant ERPs, higher paternal sensitivity at 12 months was significantly associated to a larger Nc amplitude to infant sad versus neutral emotional facial expressions (r = 0.35, p < .05).

Our findings indicate that the infant's temperament and parents' sensitive caregiving significantly contribute to infant emotion-related brain responding. Specifically, infant fear was associated with trait-like EEG asymmetry reflective of a negative, withdrawal orientation, infant approach was associated with state-like EEG asymmetry reflective of an approach orientation to others' happiness, and maternal sensitivity was associated with infant state-like EEG asymmetry reflective of a withdrawal orientation to others' distress. Only environmental factors were associated with infant ERPs to adult emotional expressions, with greater paternal sensitivity associated with neural responding reflective of heightened

attention to negative emotional expressions. These finding advance understanding of the contribution of endogenous and environmental factors to infant brain responding.

P3-H-605 - Effects of the "ACT-Raising Safe Kids" program on parenting of mothers with adverse childhood experience

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Details

Universal parenting programs provide prevention of violence against children by promoting positive parenting practices and child development at early ages (Altafim & Linhares, 2016; Branco et al., 2021; Raman et al., 2020). The ACT-Raising Safe Kids (Silva, 2011) is an evidence-based parenting program to prevent child abuse recommended by the WHO (Hardcastle et al., 2015; WHO, 2018). In developing countries, previous studies focused on children aged 3 years and above (Altafim & Linhares, 2019). Adverse childhood experiences (ACEs) are recognized as potential risks for the use of negative parenting practices (Lotto et al., 2023) and mother-child interaction (Ongilio et al., 2022). Therefore, the present study aimed to examine the effects of the ACT-Raising Safe Kids program delivered to mothers of infants (1-to-3-year-old), in groups differentiated by mothers' ACEs, to strengthen mothers' positive parenting. The sample comprised 55 mothers of 1-to-3 infants, of which 17 mothers had 4 or more ACEs (ACE^{4+}) and 38 less than 4 ACEs (ACE^{4-}). The data collection included 9 weekly sessions. In the first session (pre-intervention), the mothers answered the following questionnaires: Sociodemographic characteristics assessment; *ACT scale* (Silva, 2011; Brazilian version of Altafim et al., 2018; emotional and behavioral regulation, positive discipline, and communication); *Parenting and family adjustment scales* (PAFAS, Sanders, et al., 2014; Brazilian version Santana, 2018; parental inconsistency, coercive parenting, positive encouragement, and parent-child relationship); and *Parenting sense of competence scale* (PSOC, Gibaud-Wallston & Wanderman, 1978, Brazilian version Linhares & Gaspardo, 2017; parenting sense of competence). Subsequently, mothers participated in 8 sessions of the ACT program. The post-intervention assessment was performed at the last session using the ACT, PAFAS, and PSOC scales, and the *Adverse Childhood Experience questionnaire* (ACE, Felitti et al., 1998; maternal adverse childhood experiences). In the data analysis, the two-way mixed design ANOVA was used to compare the effects of the ACT program in groups (ACE^{4+} *vs.* ACE^{4-}), and the moment (pre- *vs.* post-intervention), controlled for socioeconomic status (SPSS 23.0; $p \leq 0.05$). The magnitude was determined by the effect size (partial Eta squared, η_p^2). The results showed, in both groups of mothers ACE^{4+} and ACE^{4-}, in comparison to the pre-intervention, there was an increase in mothers' emotional and behavioral regulation ($F [1.41] = 28.378$; $p \leq 0.0001$), with a large effect size for both groups (ACE^{4+}, $\eta_p^2 = 0.38$ and ACE^{4-}, $\eta_p^2 = 0.45$), and in the parental sense of competence ($F [1.41] = 30.113$; $p \leq 0.0001$), with a large effect size for both groups (ACE^{4+}, $\eta_p^2 = 0.55$ and ACE^{4-}, $\eta_p^2 = 0.26$). In addition, there was a decrease in the coercive practices ($F [1.41] = 30.559$; $p \leq 0.0001$), with a large effect size for both groups (ACE^{4+}, $\eta_p^2 = 0.48$ and ACE^{4-}, $\eta_p^2 = 0.36$). In conclusion, regardless of the maternal ACEs, the ACT Program had positive effects in improving maternal parenting of children at early ages.

P3-H-606 - Infant brain responses to maternal versus stranger's touch at 6 months

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Details

Social touch is a pleasurable tactile interaction that occurs naturally in social interactions between individuals. Recent studies indicate that pleasant tactile stimuli are processed by a special set of unmyelinated afferents cells present in the hairy regions of the skin: the C-Tactile (CT) fibers. Furthermore, when stimulating areas with CT fibers, neural activation patterns are partially distinct from those resulting from discriminative touch, apart from somatosensory areas, areas of the "social brain" are also recruited. Several studies confirmed that social touch can activate social regions of the brain from the first years of life, in addition to regulating social interactions, changing neural processing patterns and modeling behaviors. However, in addition to involving bottom-up mechanisms (CT fiber systems and neural activation to touch), social touch processing is also strongly influenced by top-down mechanisms, such as contextual factors - namely the identity of the toucher. During infancy, the main attachment figure is typically the mother, with most of the care provided through touch. There are also important links between maternal touch and infant behavior and development. For instance, infants aged 6 to 8 months who receive frequent maternal touch demonstrated shorter latency in exploring objects; 9-month-old infants showed a decrease in heart rate when they believed they were being touched by their mother (versus a female stranger). Despite these compelling results, available research is still scarce. Thus, our study aimed to compare the patterns of neural activation when 6-month-old infants believe they are being touched by their mothers or by an unfamiliar female. Forty infants were assessed using fNIRS, with the following regions of interest (bilaterally): Primary Somatosensory Cortex, Secondary Somatosensory Cortex, Middle Temporal Gyrus, Superior Temporal Sulcus (posterior portion) and Temporo-Parietal Junction. Infants were sat in a highchair watching a non-social video, while the mother or the unfamiliar female sat next to him. There are a total of 16 trials, 8 with the mom and 8 with the stranger woman. A trained researcher, hidden behind a curtain, applied soft hand strokes at medium speed (3 cm/s) to the infant's shoulder blade region (4 cm2). The full analysis plan can be accessed at: https://doi.org/10.17605/OSF.IO/PN5WX. We hypothesize that infants will show stronger brain activation on social areas when perceiving being touched by their mothers.

P3-H-607 - Phone call and texting disrupt mother-infant play

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Details

Disruptions to parent-child interactions during smartphone use are known as technoference (Mc Daniel & Radesky, 2018). Previous studies have demonstrated that a modified still-face paradigm where mothers look at or use a phone during the interruption period leads to poorer maternal-child interactions (e.g., Konrad et al., 2021; Myruski et al., 2017; Rozenblatt-Perkal et al., 2022). However, the

disruptive effect of a phone call versus texting while interacting with a child has not been examined yet. Texting may be more disruptive as parents exhibit a still-face. However, while having a phone call, it may be possible to maintain eye contact. In addition, the influence of a child's temperament on their behavior during technoference remains largely unknown.

We investigated the impact of a phone call and texting on mother-child interactions. Mothers and their 22-month-old infants were randomly assigned to a texting (n = 17) and to a phone call condition (n = 16). Data collection is ongoing until 20 participants per condition is reached, as determined by a power analysis aiming to reach a power of .85 with a medium effect size of .25. In both conditions, mothers were instructed to demonstrate to their infants how to operate a sound puzzle that included various animal sounds (play phase). After two minutes of interaction, mothers were either texted or called and asked about their current mood while continuing to demonstrate the sound puzzle (interruption phase). Temperament was measured using the ECQ-R questionnaire (Putnam et al., 2014).

During the interruption phase, children exhibited a higher occurrence of negative affect in comparison to the play phase, ($F(1, 31) = 5.7$, $p = .023$). Moreover, negative social bids were observed to be more frequent, accompanied by a decline in positive social bids, and a rise in prohibitive behavior during interruptions. There was no significant difference between the phone and the texting condition. No significant correlation was found between parent-reported ratings of their children's negative affect and their behavior in the interruption phase. However, the higher the mothers rated their child's effortful control, the fewer social bids the children displayed during the interruption ($r = -.46$, $p = .024$, $n = 24$).

Mothers directed their attention less and modeled the task less during the interruptions (all ps $< .05$). There was no difference between the texting and call condition. However, there was an interaction between phase and condition on mother's instructions towards their children: mothers instructed their children more how to operate the puzzle more while texting than mothers on the call.

This study contributes to the increasing evidence indicating that technoference can hinder mother-child play, and first evidence that in some instances, a call might be even more disruptive than texting with less instruction during phone calls than texts. There might be differences in how children react to disturbances based on their temperament particularly with regard to effortful control. At ICIS, we will discuss the mediating role of temperament in the relationship between maternal smartphone usage and children's response to technoference, based on the complete sample.

P3-H-608 - To what degree do toddlers actually see facial emotional expressions in the home environment?

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Details

The development of facial emotional expression (FEE) processing is protracted over infancy and early childhood, and the nature of the environmental input is theorized to be important. However, no

attempts have been made to quantify or characterize the nature of the visual environmental input at any stage of life. Toddlerhood is a key stage in socioemotional development, with increased independence shaping the environmental input in many ways, and so characterizing the degree to which toddlers see FEE could help us to understand how typical and atypical development of FEE takes place. Knowing how this compares to the visual input of adult caregivers in the same environment can help us to understand what characteristics of the visual FEE input are unique to toddlers, as well as what might characterise the visual FEE input for all individuals within the home environment: for example, if only toddlers see infrequent negative FEE, while caregivers see them frequently, this may be as a result of adults moderating their FEE around toddlers. We set out to record the egocentric visual perspectives of toddlers (N = 26; M age = 29.26 months) and their caregivers in their home environments and quantify the degree to which these egocentric perspectives contain different FEE using a machine learning algorithm. We hypothesized that while both positive and negative FEE would be present in the view of the toddlers, positive and neutral FEE would be more frequent, and the least common FEE in the toddler view would be anger, fear and disgust (which would be more frequent in the caregiver view). Broadly, these hypotheses were confirmed, though the visual input of toddlers and their caregivers was markedly similar. Around half of face frames from each perspective received the label neutral (for toddlers, M = 46.94%, SD = 8.25%; for caregivers M = 48.92%, SD = 10.76%), with happiness being the second most common label (M = 15.47%, SD = 5.32% and M = 19.58%, SD = 6.16% respectively). Negative, threat-related FEE were especially infrequent in the egocentric view, particularly disgust, which was assigned to M = 3.56%, SD = 2.43% of face frames in the toddler view and M = 1.45%, SD = 1.25% of those in the caregiver view. So, overall, most faces in the view of both toddlers and their caregivers are positively valanced or neutral, with negative FEE. Since there is no theoretical reason to believe that negative FEE would be more frequent in the child view pre-toddlerhood, this suggests that emergence of the ability to identify and understand these FEE develops with very sparse input. These statistics being reflected in the caregiver view suggests that frequent neutral and positive FEE, with infrequent negative FEE, is not unique to the toddler view, and perhaps not the result of response moderation of others. Given the great variation in FEE seen here, future research should examine individual differences in FEE frequency in the visual input, as well as the degree to which younger infants see FEE.

P3-H-609 - 2-Brain Regulatory Attunement Impact of Neonatal Stress (2-BRAINS). A mother-infant inter-brain synchrony pilot study

Elisa Roberti [1], **Elena Capelli** [2], **Miriam Pili** [3], **Valentina Riva** [4], **Lucia Billeci** [5], **Giacomo Novembre** [6], **Giacomo Cremaschi** [3], **Silvia D'alfonso** [3], **Yaren Günay** [3], **Livio Provenzi** [3]

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Details

The early emergence of dyadic attunement in parent-infant interactions is fundamental to many aspects of development (e.g., learning to coordinate with others and to self-regulate) (Tokariev et al., 2019). Hyperscanning is an innovative approach to investigate the neurophysiological processes underlying early parent-infant interactions (Montague 2002) by allowing the simultaneous recording of dyadic Inter-Brain Synchrony (IBS) in live settings. While several studies examined mother-infant IBS during

face-to-face exchanges (e.g., Wass et al., 2020; Endevelt-Shapira et al., 2021; Nguyen et al., 2023), less is known about how interferences in the interactions affect IBS.

In this study, we aim to investigate IBS in dyads of mothers and their 9-month-old infants during an experimentally disrupted parent-infant interaction (i.e., adapted still-face paradigm, SFP; Tronick et al., 1978) while their brain activity is synchronously recorded through electroencephalography (EEG). We hypothesize that the IBS established in the 2-minute play episode will be lost during the 1-minute still-face perturbation. Moreover, we aim to investigate whether and when IBS is regained during the 2 minutes of the reunion.
Preliminary analyses were conducted on 15 dyads (mean age: 10 months and 9 days; SD =23 days; 9 males). After preprocessing the EEG data, Phase-Locking Values (PLVs) in the alpha (4-7 Hz, Endevelt-Shapira et al., 2021) and theta (8-12 Hz, Smith et al., 2021) frequency bands were calculated. Separate 2x2x3 repeated measures ANOVAs were carried out with region (frontal and central electrodes), lateralization (left and right electrodes), and phase (play, still, and reunion) as within-subject factors. From this partial sample, no significant differences emerged. As can be observed from Figure 1, the high standard errors suggest great variability between dyads, and this may be the reason for non-significant effects. Nonetheless, especially in frontal regions in the alpha frequency band, a trend similar to the one we hypothesized could be observed: a decrease in PLV in the still phase and a tendency to return to the initial PLV in the reunion phase.

It is possible that other IBS indexes could be more sensitive to the dyadic neural dynamics occurring during and after interactive disruptions, and we plan to have results on Cross-frequency PLVs and Circular Correlations (Turk et al., 2022) by July 2024, together with the complete sample size of 30 dyads.

Translational applications of such paradigms might help reveal early markers of less-than-optimal socio-cognitive development in several neurodevelopmental conditions and risks such as preterm birth (Roberti et al., 2023).

P3-H-610 - Co-regulation and infant distress vocalizations observed during mother-infant interactions: Influences of maternal depression and different contexts

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Details

Mother-infant interactions are co-regulated (i.e., shaped by both mothers and infants) and are believed to provide the foundation for developing self-regulation and healthy mother-infant relationship quality. We examined the implications of maternal depression status and contextual demands (e.g., reinstating the interaction after a period of maternal unavailability and vocalized infant distress) on observationally coded co-regulation in mother-infant dyads (n = 40) at four-months postpartum. Dyads participated in the Still-Face (mothers were asked to retain a neutral expression and not respond to their infant's bids

for attention) and Separation (mothers were close, but out of their infant's sight) procedures whereby perturbed periods of maternal emotional and physical unavailability took place (SF procedure; Tronick et al., 1978; SP procedure; Field et al., 1986). Co-regulation was captured in terms of mutual engagement and activity levels using the Revised Relational Coding System while dyads interacted freely before and after the SF and SP perturbations (RRCS; Fogel et al., 2003). Infant distress vocalizations (e.g., cries, whimpers) were coded during the SF and SP perturbations. MANOVA results revealed that dyads in the depressed group had significantly more unilateral co-regulation (i.e., one-sided attempts at social engagement) than non-depressed counterparts following the SF and SP perturbations. In addition, mixed factorial ANOVAs revealed that infants of mothers with depressive symptoms also had significantly more distress vocalizations during the SP perturbation compared to their non-depressed counterparts. Furthermore, co-regulation in the depressed group was less disrupted by the SF perturbation, despite infants of depressed mothers having similar levels of distress vocalizations in response to the SF perturbation. Together, results suggest that co-regulation and infant distress vocalizations in response to periods of maternal emotional and physical unavailability are altered by maternal depression status. Indeed, maternal depression appears to change the way in which the dyad's co-regulatory system adapts to changing contextual demands. The findings highlight important targets for risk identification, as well as parenting interventions and practices. Specifically, comparing co-regulation in depressed vs. non-depressed healthy counterparts may help identify which infants and relationships are at the greatest risk to be negatively affected by maternal depression and under which contextual circumstances.

P3-H-611 - The development of empathy in infancy: The role of interoception and natural social statistics

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Details

Interoception has been proposed to be involved in empathy through processes such as affect sharing (Grynberg & Pollatos, 2015), emotion recognition (Terasawa, Moriguchi, Tochizawa & Umeda, 2014) and self-other distinction (Palmer & Tsakiris, 2018). However, little is known about the characteristics of these relations in infancy. The aim of this study is to address these outstanding questions. In particular, we test the hypothesised relations between interoception and affect sharing responses elicited by observing peers' emotions, as well as the relation between interoception and the frequency of emotional facial expressions observed by infants in everyday life. Previous research has shown that heart-evoked potential (HEP), as an index of interoception, becomes greater when observing video clips of negative emotions in 5-month-old infants (Maister, Tang & Tsakiris, 2017). This suggests that HEP can be useful in investigating the relation between interoception and affect sharing in infants. Additionally, previous studies also suggest that EEG frontal power asymmetry (alpha band) reflects affect-sharing mechanisms (Crespo-Llado, Vanderwert, Roberti & Geangu, 2018). Therefore, to address the relationship between HEP and affect sharing, we collected 6-month-old infants' ECG and EEG responses to peers' positive, negative and emotionally neutral expressions (i.e., videos of other infants laughing, crying and babbling) in a lab-based task (Geangu, Hauf, Bhardwaj & Bentz, 2011). From this task, we extracted EEG frontal power asymmetry (alpha band) and HEP mean amplitude as a function of emotion

condition. We also recorded infants' egocentric audio-visual viewpoint in their home, using age-specific head-mounted cameras (Geangu et al., 2023), in order to quantify the frequency of emotional expressions observed in the home environment. We expect to find that changes in EEG frontal power asymmetry (negative vs neutral, positive vs neutral) will be significantly correlated with HEP mean amplitude during these different emotion conditions. We also expect that this relationship will be strongest for the negative condition, based on previous findings of HEP and infants' observation of different emotion conditions (Maister et al., 2017). Finally, we expect that the relationship between EEG frontal power asymmetry and HEP mean amplitude will be significantly correlated with the frequency of positive and negative emotional facial expressions observed by infants in their home environment. These results will contribute to our understanding of how empathetic responses change throughout infancy and the potential processes involved.

P3-H-612 - Predictive role of maternal tactile behaviors in infants' neural responses to social touch: An fNIRS study

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Details

Touch is an essential dimension of the mother-infant relationship. However, there are few studies exploring infants' brain responses to maternal touch and its associations to other aspects of the mother-child relationship are scarce. Our previous work showed an association between lower maternal sensitivity and infants heightened temporal response to affective touch at 12 months. However, sensitivity is a general indicator of the quality of mother-infant interactions, not an assessment of the quality of maternal infant-directed touch. This study evaluates the predictive role of maternal touch behaviors in mother-infant interactions on infants' brain responses to touch perceived to be from their mothers during a neuroimaging session. A valid sample of 25 6-month-old infants and their mothers will be collected for this work. Infants will be evaluated using functional near-infrared spectroscopy (fNIRS) with the following procedure: Touch is applied on the infant's shoulder blade by a trained experimenter hidden behind a curtain on 16 trials (baseline + touch). On half of them, the mother is sitting next to the infant and on the other half, a non-familiar woman. Here, only the mother trials will be analyzed. The quality of maternal tactile behaviors is assessed thorough recordings of 9-minute mother-infant interactions. Maternal behaviors is coded by a trained researcher (blind to the study hypotheses), on a second-by-second basis, into one of six mutually exclusive categories: 1) Affectionate Touch; 2) Static Touch; 3) Playful/Stimulating Touch; 4) Instrumental Touch; 5) Incidental Touch; 6) Intrusive/Negative Touch. The complete analytical plan can be accessed at OSF Preregistration Website. With this study we expect to enhance our understanding of infant neural responses to social touch and the related factors within maternal-child interactions.

P3-H-613 - Family meals as a context for learning positive behavior: Examining the contributions of feeding strategies and mealtime emotional climate

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Details

Background and Aims: The early childhood years are an important time for establishing positive behavioral patterns. Parents teach children how to manage their behaviors by structuring the home environment and communicating expectations. One goal-oriented setting in which children are challenged to manage their emotions and behaviors is during family mealtimes. Beyond the act of sharing a meal together, several aspects of the meal, including mealtime structure, parent feeding strategies, and mealtime emotional climate have been linked to child eating habits and behavior *during* family meals. For example, greater mealtime structure, characterized by routine-oriented and distraction-free meals, is associated with lower food fussiness and more enjoyment of food in children (Powell et al., 2017; Finnane et al., 2017). Additionally, the extent to which parents strive to control their child's intake rather than allowing the child to control their intake can impact children's sense of autonomy and appetite self-regulation. Permitting the child to listen to their hunger cues and manage their intake is associated with better eating habits (Francis et al., 2022). Few studies, however, have examined whether these benefits extend beyond the family meal setting.

The current longitudinal study examined whether positive feeding strategies and mealtime structure when children were 24 months of age were associated with conduct and emotional problems at 36 months. Additionally, we considered whether potential associations were moderated by mealtime emotional climate, or the degree to which interactions within the meal were positive or negative (Smith et al., 2022).

Method: Dyads (n = 270) who participated in the Play & Grow study (2017-19) completed questionnaires at 24 months of age about mealtime structure (α = .714), child control of intake (α = .735), and parent control of intake (α = .684) using the *Feeding Strategies Questionnaire* (Berlin et al., 2009). Additionally, mealtime emotional climate was assessed during a family mealtime interaction that was coded for the extent to which family members displayed mutual enjoyment of the meal, characterized by a relaxed and tension-free environment. Greater scores on the mealtime emotional climate measure indicated higher-quality interactions. Finally, child behavioral difficulties (i.e., conduct and emotional problems) were assessed using the *Strengths and Difficulties Questionnaire* (Goodman, 1997).

Results: Linear regression analyses adjusting for gestational age, mothers' education, and family emotional climate revealed that child control of intake was associated with reduced emotional problems (β = -.17, p < .05). Next, to assess whether patterns of association differed when mealtime emotional climate was high vs. low, we stratified the data by mealtime emotional climate (dichotomized at the median value of 3). Mealtime structure emerged as a predictor of conduct problems when mealtime emotional climate was high-quality (β = -.58, p = .0003) but not when mealtime emotional climate was low-quality (β = .10, p = .56). See Figure 1.

Conclusion: Findings revealed aspects of mealtime quality are linked to child behavior beyond the mealtime context. It is especially noteworthy that mealtime structure was linked to reduced conduct problems when mealtime emotional climate was high. Implications will be discussed.

P3-H-614 - Parental adversity and child emotionality: The impact of economic strain on infant development

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Details

Introduction: Parenting under conditions of material hardship can exacerbate the challenges of nurturing positive child emotionality and behavior. When families deal with financial strain, meeting basic needs becomes a challenging task, which can often result in heightened parental stress. The profound strain can manifest as increased irritability and impatience, fostering an environment where children are more likely to internalize negative emotions. The scarcity of resources may limit opportunities for enriching experiences, hindering the development of a supportive and stimulating atmosphere critical for emotional well-being. Parents facing material adversity may struggle to provide consistent and responsive caregiving, affecting the child's sense of security and emotional regulation. Understanding the intricate interplay between material hardship, parental aggravation, and their impact on child emotionality is essential for designing interventions that address not only immediate needs but also promote long-term positive outcomes in family dynamics and child emotional development.

Objective: The current study aims to examine relationships of aggravation in parenting and material hardship on child emotionality/temperament and positive behavior and mediating factors of maternal anxiety and depression across time.

Methods: We utilized secondary data from the Future of Families and Child Wellbeing (FFCWB) Study, focusing on Baseline and Wave 1, which corresponds to birth and age one; n = 2,202, boys = 52.2%, White, 21%, Black, 47.5%, Hispanic, 27.3%, other, 4%. We investigated the relationships between child temperament at birth and other variables by utilizing the following measures in the dataset: parent-report of child temperament by the *Child's Emotionality and Shyness (EAS Temperament Survey),* child adaptive social behavior per the *Adaptive Social Behavior Inventory (ASBI),* maternal depression and anxiety through the *Composite International Diagnostic Interview Short-Form (CIDI-SF*), aggravation in parenting through *Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID*), and material hardship through *Basic Needs – Ability to Meet Expenses*" section of *the Survey on Income and Program Participation (SIPP)*. Parallel mediation and multiple regression analyses examined the variable relationships.

Results: Maternal depression partially mediated (β = .025; p<0.01) the relationship of aggravated parenting (β = .313; p<0.01) and emotionality while maternal anxiety did not demonstrate a mediative effect. In contrast, while direct effects on maternal anxiety, maternal depression, and positive behavior were evident (β = .091, p<0.01; β = .138, p<0.01; β = -.044, p<0.01), no mediative effects were indicated between aggravated parenting and positive behavior. There was significant partial mediative effects between material hardship and emotionality through maternal depression (β = .263; p<0.01), and the relationship between material hardship and positive behavior was fully mediated by maternal depression (β = -.037; p<0.01).

Conclusions: While maternal anxiety did not meditate effects on child emotionality or later positive behavior, maternal depression partially mediated the effects from aggravated parenting and material hardship. These results highlight the dual impacts of parenting and direct economic strain on infants, though the precise effects differ across time, indicating that the direct and mediative effects of maternal depression may be age or context dependent.

P3-H-615 - Maternal and paternal sense of efficacy as moderators of the link between prenatal and postnatal parenting stress and family alliance at 3 months

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Details

Parents may report high levels of stress during the perinatal period. Mothers may for example report the pressure to be a “good mother” as particularly stressful; fathers may mention the fear of incompetence related to child care as a stressor. Unsuccessful coping with stress put parents at risk of multiple negative consequences, such as parental burnout, alteration of the couple relationship, and alteration of parenting behavior, which will ultimately affect the infant’s development. One of the parental characteristics that has been shown to moderate the effect of stress is the parental sense of efficacy, that is, the sense a parent has of being able to positively influence the development of his or her children. To date, while the deleterious effect of stress on relationships has been documented, no studies have assessed the links between parental stress and family interactions in terms of family alliance and the extent to which each parent’s sense of efficacy interacts to moderate these links. Family alliance refers to the family’s ability to coordinate to successfully fulfill a task—be it to play together, to have a meal, or to participate in any kind of family activity. This study aimed at filling this gap. 65 heterosexual dual-parent families participated at the fifth month of pregnancy (T1) and 3 months after birth (T2). All families were from an upper-middle class background. They answered standardized questionnaires about parental stress (at T1 and T2) and parental efficacy (at T2). They were also observed while playing with their infant in the Lausanne Trilogue Play (at T2). Family interactions were filmed and double coded with a standardized coding system by independent raters for the assessment of family alliance. The main results are the followings: (1) bivariate comparisons show that there is no difference between mothers and fathers regarding stress or the sense of efficacy; (2) maternal or paternal postnatal stress has a direct link with higher family alliance; (3) structural equation modeling showed that the links between stress and family alliance are moderated by complex interaction effects between maternal and paternal senses of efficacy, mainly regarding prenatal stress. For example: Higher maternal prenatal stress was predictive of lower alliance when maternal sense of efficacy was high and paternal sense of efficacy was low; higher paternal prenatal stress was predictive of lower alliance when paternal sense of efficacy was high and maternal sense of efficacy was medium. Globally, our results have confirmed that parental stress has an impact on family alliance, although there is a straightforward link only for postnatal stress; unexpectedly, however, a higher stress was linked with a higher family alliance. Higher parental stress may thus encourage collaboration and mutual support in the interaction. Our results also confirmed the moderating role played by the interplay between both parents’ sense of efficacy, as they highlighted several crossover effects that show the importance of considering both

parents in order to understand how parental stress may affect family interactions, and, ultimately, the development of the infant.

P3-H-616 - Paternal sensitivity in the first year of life: The role of fathers' engagement in basic care activities

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Details

Some findings suggest that fathers more involved in direct caregiving activities in the first year of the infants' lives may be more sensitive to their behavior. This study analyzed paternal involvement and sensitivity in first-time fathers throughout the infant's first year. We adopted a longitudinal multiple case study design with assessments in the infants' 5th, 7th, 9th, and 11th months. Three fathers and their infants took part in the study: one *primary caregiver*, who regularly performed basic care addressing the infant's physical and emotional needs; one *secondary caregiver*, who regularly assisted the partner in direct care when necessary; and one *provider caregiver*, who eventually played and held the infant, but whose central role was financially providing the family. In each assessment, the three fathers answered a semi-structured interview on paternal involvement, and infants and fathers were observed during a 10-minute free-play session. We proceeded with data analysis in four steps. The interview content was transcribed and described in the first step to gain a holistic understanding of the paternal involvement patterns. In the second step, the observations were submitted to microanalysis. The 10-minute videos were coded in 12-second intervals. In the first half of the interval, infant behavior was coded into six categories: smiling, emitting sounds, crying, moving/grabbing, playing with the father, and playing alone. Paternal responses were coded along the 12-second interval in seven categories: speaking to the baby, smiling to the baby, holding/rocking the baby, stimulating with or without an object, destabilizing/moving the baby's body, commands, and acting intrusively. Reliability levels of the two independent coders reached 0,78 for infants' behavioral categories and 0,84 for paternal responses. In the third step, we used the logical model to articulate data on paternal involvement to data on paternal sensitivity. The results indicated that the primary caregiver, who had been continuously involved with basic care, did not report difficulties in complex tasks such as soothing the baby and displayed high frequencies of non-directive speech, in addition to easily engaging the infant in the interaction. The secondary caregiver was occasionally involved in direct caregiving in the fifth month but reported a progressive increase in his involvement in basic care on weekends over the first year. He reported some difficulties soothing the baby and putting him to sleep. He displayed decreased non-directive speech and intrusiveness and increased directive speech during interactions during the four assessments. The provider caregiver, who was rarely involved with basic care tasks, reported remarkable difficulties in soothing the baby and putting him to sleep, in addition to having responded with frequent commands and intrusive behaviors during the interaction. In the fourth step of the analysis, the cross-case synthesis technique showed that, compared to the primary and secondary caregiving fathers, the provider caregiver used less non-directive speech and was more intrusive during the interaction. These findings suggest that continuous involvement in basic care activities offers opportunities for the father to perceive and train skills to respond sensitively to the infant's behavioral changes during the first year.

P3-H-617 - Can you relate? Examining longitudinal changes in emotion understanding across early childhood

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Details

Emotion understanding involves appreciating the relation between an emoter and a causal referent. Separate studies have shown that discrete emotions differentially guide adults' and preschool-aged children's attention to elements of relational context (Knothe & Walle, 2018, 2023). However, research has yet to examine emoter-referent understanding in the toddler years and how it may be related to parent emotion socialization across development. This study longitudinally examined changes in the discussions of parents and their children about discrete emotions starting when the children were toddlers.

Children (N = 296; 157 boys, 139 girls) and their primary caregivers (98% female, 2% male; 67% White, 8% Black, 15% Hispanic, 2% Asian American, 1% American Indian or Native Alaskan or Native Hawaiian or Other Pacific Islander, 6% Mixed or Biracial, 1% Identified as 'Other') were observed annually in their homes for four years starting when the children were toddlers (M_{age} = 2.44, SD = .26). Parents and children were video recorded discussing an emotion storybook featuring wordless, professionally animated images of different children experiencing facially and posturally a discrete emotion (i.e., Joy, Sadness, Fear, Anger, Disgust, see Figure) in response to an eliciting situation (e.g., dropped ice cream). All stimuli were validated by a separate sample of adults (N = 105) as depicting the target emotion.

The recordings of parent-child conversations were transcribed and two variables were extracted for each child and parent page transcript: (1) *referent* score, or frequency of references to the causal referent (e.g., the dropped ice cream), and (2) *emoter* score, or frequency of references to the emoter ("he," "she," "that girl," etc.). We created separate child and parent emoter-referent *difference scores* by subtracting each page's referent score from the emoter score to capture the relative emphasis of the emoter versus the referent, with positive scores representing relative increased emphasis on the emoter compared to the referent and negative scores indicating a relative increased emphasis on the referent compared to the emoter.

Children's and parents' difference scores were analyzed with separate factorial repeated-measures generalized mixed linear models with emotion and wave as within-subjects factors. For children there were significant effects of wave, $F(3, 1739) = 4.91$, $p = .002$, and emotion, $F(4, 2751) = 23.31$, $p < .001$, and a significant Wave × Emotion interaction, $F(12, 2924) = 2.09$, $p = .01$. Children emphasized the emoter more than the referent for sadness at all waves and anger at 2.5 years and 4.5 years but emphasized the referent more than the emoter for disgust at all waves with the greatest emphasis happening at 2.5 years compared to later waves (see Table).

For parents there also was a significant effect of emotion, $F(4, 1309) = 43.23$, $p < .001$, and a significant Wave × Emotion interaction, $F(12, 3332) = 2.75$, $p = .001$, but there was no significant effect of wave. Interestingly, parents' difference scores did not differ by emotion when children were 2.5 years old, but

they began to differ by emotion starting when children were 3.5 years old, largely due to changes in parents' difference scores for Joy and Fear. Taken together, these results show nuance in the development of children's emotion understanding from infancy to kindergarten. Implications for emotion socialization will be discussed.

P3-H-618 - What she believes or what she says? The relation between maternal beliefs, mental state talk, and children's theory of mind

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Details

The present study provided a novel examination of how children's theory of mind might be related to two maternal attitudes: (1) social dominance orientation (SDO: the belief that inequalities in society are justified), and (2) right-wing authoritarianism (RWA: a belief in following established authorities). We reasoned that these attitudes could affect maternal talk in that mothers with high SDO and RWA would be less likely to use mental state talk to explore peoples' desires and feelings, particularly when talking about individuals of an outgroup (e.g., a different ethnicity). As a consequence, there might be links between maternal attitudes and children's theory of mind. We measured SDO and RWA in mothers, gave children theory-of-mind tasks, and measured the mental state talk of 79 New Zealand mothers when asked to describe pictures to their 2- to 5-year-olds. Mothers with high SDO and RWA provided less mental state talk when describing individuals of a different ethnicity, and mothers with high SDO and RWA had children with a worse theory of mind. The present findings provide unique information regarding the role of parent attitudes in children's theory of mind.

P3-H-619 - Caregiver-infant co-arousal patterns during co-sleeping on Tanna, Vanuatu

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Details

There is a debate among public policy makers and the scientific community regarding the safety of co-sleeping in the first year of life. Parent-infant and/or family co-sleeping have been argued to be a significant contributor to sudden infant death syndrome (SIDS) in the first year of life. While the public policy campaigns indicate that choosing to sleep with the infant in the first 6 months can be a potentially life-threatening hazard for the infant, sleep experts argue that the evidence linking co-sleeping with SIDS is correlational and misses other important contributors. They also indicate that co-sleeping may prevent SIDS in the first year of life. They argue for protective factors of co-sleeping such as – longer duration of breastfeeding (a known protective factor against SIDS) when possible, and synchronous sleep rhythms between the parent and infant. Research supporting this comes primarily from laboratory studies in the US investigating new mothers and infants co-sleeping compared to mothers and infants

sleeping in adjacent rooms. Our current understanding of maternal-sensitivity and sleep arousal patterns during co-sleeping are limited in scope. The aim of the present study was to examine sleep arousal patterns and maternal-sensitivity in a non-Western, rural society where co-sleeping is prevalent. In the current study we examined sleep patterns of mothers and infants in a community on Tanna Island, Vanuatu. Co-sleeping is the dominant form of infant sleep choice on the island and half of the households did not have access to electricity at the time of the study, making it an ideal location to examine sleep patterns. Our aim was to describe the co-arousal patterns in a society that practices co-sleeping, thereby enabling us to better understand the complexity of co-sleeping patterns between mothers and infants in diverse cultural contexts. We examined co-arousal patterns of 27 mother-infant dyads. The average age of infants was 5 months and mothers were 30 years. Dyads were recorded for 7 nights through the use of actiwatches. The collected data was sampled at a rate of once every 15 seconds. Mothers were also interviewed about their sleep routine and practices. A mean correlation of r = .236 was found between mother and child activity and this effect was of medium size supporting the conclusion that mothers did in fact display co-arousal with their children. Furthermore, the mean correlation of mothers' activity in response to their children (mean r = .236) was greater than the mean correlation of children's activity in response to their mothers (mean r = .216), $t(26) = 5.322$, $p < .001$, CI95% = .012, .028. This suggests that when the infant wakes, the mother wakes in response to the infant suggesting that, in line with McKenna and McDade (2015), the risks of co-sleeping are likely a result of several factors but can be a safe practice for parents and infants in certain settings. More research with fathers and siblings is needed to better establish the sensitivity of non-maternal sleeping partners.

P3-H-620 - Age-related shifts in bilateral connectivity to increased frontal specialization in infants in the context of social rivalry

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Details

Biologically based attachment motivational systems promote infant-caregiver relationships that in turn serve to protect infants from environmental threats. One such recurring threat in early development is the loss of maternal attention to another infant. Affective reactions to this social usurpation can serve the purpose of promoting behaviors designed to regain the exclusive attention of the mother. Researchers have identified approach-motivated behaviors (proximity, gaze, and reach or touch) toward the mother as part of jealousy protests in social-rival paradigms (Hart & Carrington, 2002; Mize et al., 2014). Moreover, Mize and Jones (2012) found a relationship between infants' tonic brain activity patterns measured by electroencephalogram (EEG) and approach-style jealousy responses. It is becoming increasingly evident that infants strive to protect important social relationships, yet the underlying affect (anger or sadness) remains unclear. The aim of the current study was to replicate behavioral findings of previous studies and further examine psychophysiological processes (EEG coherence) that underlie social processing and emotional expressions of jealousy during the first 18 months of life. A 2 (task) X 5 (infant behavior: negative affect, arousal, gaze, reach/proximity seeking, and global approach) X 2 (infant age) mixed-model MANOVA was conducted. Infant age category (6- to 9-months and 12- to 18- months) was the between-subjects factor. Infants displayed more jealousy-type

behaviors when faced with social threat compared to control condition across age ($F(1,138) = 7.52$, $p<.001$), although the difference in infant behavior between tasks being more pronounced in the 12- to 18-month-old infants. Infants in the 6- to 9-month-old category and the 12- to 18-month-old age category displayed similar levels of jealousy-type behaviors during the social threat task (see Figure 1). A series of Pearson correlations revealed different relational patterns in physiology and behaviors across age. A significant correlation emerged between mother-directed reaching behavior when 6- to 9-month-olds were faced with social threat in both left- ($r= -.345$, $p= .019$) and right- ($r= -.451$, $p= .002$) hemispheres in frontal region coherence. In addition, negative vocalizations in 6- to 9-month-old infants were correlated with right hemisphere midfrontal/occipital ($r= .313$, $p= .034$) and right hemisphere lateral-frontal/occipital ($r= .303$, $p= .041$) coherence. A significant negative correlation emerged in the 12- to 18-month-old sample between right hemisphere mid-frontal/central EEG coherence and global mother-directed approach ($r= -.267$, $p= .041$). Although younger infants engaged in similar jealousy protests when a perceived social rival usurped their mother's attention, a developmental shift was found in resting-state EEG from bilateral coherence in younger infants to increased frontal specialization by 18-months. Furthermore, 6- to 9-month-old infants exhibited more frontal neuro-connectivity in the right hemisphere of the brain, an area related to negative emotions. The development of jealousy expression and patterns of brain development may have evolved as a mechanism for infants to communicate their need to regain maternal exclusive attention. Further discussion of these important socio-emotional and neurophysiological correlates in infants will be presented.

P3-H-621 - Infant 6-month psychophysiology during interaction with mother is differentiated by 12-month attachment quality

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Details

Background: Infant-parent attachment relationships are essential for children's psychological and physiological well-being. When infants perceive their caregiver as consistently available, they learn to rely on caregivers for comfort when they feel frightened, threatened, or stressed; and as a secure base, from which to explore the world and learn about the environment (Bowlby, 1980; Cassidy et al., 2013). Since infants use caregivers to regulate their distress under threatening conditions, the quality of early attachment relationships can guide biobehavioral responses to threat, including infant stress reactivity and emotion regulation (Dagan et al., 2018; Diamond et al., 2015). Secure attachment reflects parent-child relationships in which the caregiver is responsive when support and comforting are needed by the infant. In contrast, when caregiving behavior is characterized as harsh, rejecting, or chaotic, children tend to evidence patterns of insecure attachment orientations. Psychobiological research focused on attachment-related stress regulation and its effect on the reactivity of the hypothalamus pituitary adrenal (HPA) axis and endocrine response in women provides evidence that mothers with secure attachments, were noted as having a moderate response to stress tasks with lower cortisol and greater levels of oxytocin when compared to women with insecure attachment. Despite these findings in adults, little is known about the association between attachment and neuroendocrine response in infants.

Methods: We analyzed data from the Mood, Mother, and Infant Study (N=222). Mother-infant dyads were followed from the third trimester of pregnancy until 12 months postpartum. During the 6-month postpartum lab visit, mother-infant dyads engaged in a 10-minute recorded free play (FP) followed by a repeated Still Face Paradigm (SFP, Tronic et al., 1978). Saliva from infants was collected before and after FP and at 1-, 20- and 30-minutes following completion of the SFP, and blood samples from mothers were collected from mothers after the FP interaction, 10-minute baseline,10-minute pre-still face rest, and at the 10-, 20-, and 30-minute reunion/recovery period. Blood samples were collected into pre-chilled vacutainer tubes, immediately cold-centrifuged, aliquoted into pre-chilled cryotubes, and stored at -80° Centigrade (C). Infant salivary samples were immediately frozen at -80° C until assay. At 12 months, infant responses to maternal separations and reunions were observed and coded using the Strange Situation Paradigm (SSP, Ainsworth et al. 1978).

Results: Using linear mixed models, we examined associations between emerging attachment quality (defined as secure or insecure) and neurophysiological response to a mild stress task across time points. Controlling for child sex, household income, and maternal depression, we found that infants with secure attachment, on average, had higher OT levels and lower α-Amylase levels across all assessment time periods compared to insecure infants. In contrast, we found no significant differences between secure and insecure infants with cortisol reactivity. Additionally, mothers of children with secure attachment did not differ from mothers of insecurely attached children in OT or cortisol levels over assessment time points.

Conclusion: Findings suggest that attachment is related to infant physiological response to stress, however infant attachment may not be related to mothers' response to stress.

P3-H-622 - What does he want?: Infants' understanding of goals and desires

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Details

Adults are able to attribute and infer mental states to assist with their predictions about the goals or future actions of others (Gergely & Csibra, 2003). One mental state used in this process is desire. For example, when watching a friend cook and simultaneously open a bottle of wine. If you know that they don't like wine, you might infer that their goal and subsequent action will be to add it to their cooking. However, if you know the bottle they opened is their favourite wine, you may instead infer that they will serve it alongside the food. How does this ability to integrate others' desires into their goal attributions develop?

From 9-months-old, infants will attribute a goal to an actor's selective reach for an object (Woodward, 1998). Across the second year of life, infants begin to use overarching goals to infer which object will lead to an actor completing a signalled goal (e.g. a spoon to complete the goal of eating; Anderson & Martin, 2023; Dresel et al., in review). Research also suggests that from 24 months, toddlers begin to pass a Diverse Desires task (e.g., Repacholi & Gopnik, 1997), which suggests a developing understanding

of desires (for review, see Ruffman et al., 2018a). The present study aims to explore how infants are able to transition from an understanding of overarching goals to an understanding of desires and thus how these abilities may be linked. Additionally, we also plan to investigate how this transition occurs. Previous research suggests that there is an association between children's own mental state vocabularies and scores on Theory of Mind tasks (Ruffman et al., 2018b), as well as an association between parental use of mental state language and toddler's mental state vocabularies (Taumoepeau & Ruffman, 2006). We thus ask whether the development of infants' understanding of desires is related to their expanding vocabularies, facilitated by parental use of mental state language.

In this study, 48 18- to 21-month-olds (18m15d; 21m15d) will participate in three tasks. A Goal Attribution task will test whether infants are able to integrate others' desires into their goal attributions. An actor will present a novel object that can be used with two tools to produce two different sounds, one of which is liked by the actor while the other is disliked. The actor will then ask for the infants' help to choose one of the tools. The second task is a Desire Understanding task, adapted from the Repacholi and Gopnik (1997) Diverse Desires task. Infants will be presented with biscuits and broccoli, and asked which one they like best. The actor will then display the opposite preference, before asking for the infants' help in choosing one to eat. Infants' performance on these two tasks will be compared to investigate if passing one task increases the likelihood of passing the other. Caregivers will report their infants' vocabularies, which will also be compared to their performance on both tasks. Finally, caregivers will complete a Book Reading task, where they will describe eight photos to their infants. We will code a range of speech acts performed by parents during the task, such as use of desire language, to explore whether range of parental language facilitates their infants' developing understanding of desires.

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P3-H-623 - Predictors in parents' youth of responses to infant pain – an observational cohort study

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Details

Objective: Children start experiencing pain already early in life. Through social learning mechanisms, parental responses to their child's pain may play an important role in shaping the child's pain susceptibility throughout life. Routine vaccinations in infancy can be used as a setting to study parental responses to their child's pain. Research has shown relations between parental behaviour and infant pain and distress in the vaccination context, and has identified coping-promoting and distress-promoting behaviours. Parent's own emotions and experiences related to pain and health may influence their behaviour during painful events of their child. So far, only associations between current parental factors and responses to their child's pain have been shown, such as anxiety right before the vaccination. It is still unknown if experiences and emotions related to pain and health in the parent's youth contribute to the way they respond to their infant's pain later on.

The aim of this study is to investigate longitudinal associations between pain and health anxiety in the parent's youth, and emotional, behavioural and cognitive responses to their 3-month-old infant's pain in the context of routine vaccinations years later.

Methods: This study is conducted in the Tracking Adolescent's Individual Lives Survey (TRAILS) cohort, a population-based prospective cohort that started in 2011 with 10-12-year-old children. At ages 13, 16 and 19, participants completed a self-reported pain questionnaire. At age 19, the Whitely Index was used to assess health anxiety. Inclusion of the offspring cohort TRAILS-The next generation (TRAILS Next), following TRAILS participants who have become parents and their children, began in 2020. All participants with a 3-month-old infant are invited to participate in the current vaccination study. Video recordings of infant's standard vaccinations at 3 months old are double coded in The Observer XT for parental behavioural responses, using the Measure of Adult and Infant Soothing and Distress (MAISD) and Opportunities to Understand Childhood Hurt's Inoculation Evaluation (OUCHIE) tool. Infant pain-related distress is coded using the Face, Legs, Activity, Cry, Consolability (FLACC) scale. Parents report on their state anxiety using the State-Trait Anxiety Inventory (STAI) preceding the vaccination, and estimate their infant's pain using a Numeric Rating Scale after the vaccination. Multiple regression analyses will be used to examine associations between parental youth pain and health anxiety and 1) parental coping-promoting and distress-promoting behaviour; 2) parental estimation of their infant's pain. We will subsequently test if parental state anxiety mediates these relations. Associations will be adjusted for infant pain-related distress, parent sex and the number of older children of the TRAILS participant.

Anticipated outcomes: Currently, the sample comprises 143 parent-infant dyads (81.1% mothers) and inclusion is ongoing. We will report on the study's first results. The findings of this study may aid in identifying early risk factors for engaging in unfavourable parental pain responses, possibly contributing to transmission of pain susceptibility to their offspring. This is important for the development of prevention and intervention strategies.

P3-H-624 - Correlates of dynamic change in maternal physiology during the Still-Face Paradigm: Replication & extension of Xu and Groh (2023)

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Details

Recently, Xu and Groh (2023) demonstrated that mothers' states of mind with respect to attachment predicted dynamic change in their respiratory sinus arrhythmia (RSA), an indicator of physiological regulation, across episodes of the Still Face Procedure. Specifically, mothers with higher secure base script knowledge, a measure of adult attachment security, demonstrated greater dynamic change in RSA across the Still Face than mothers with low secure base script knowledge. The authors speculated that the high RSA withdrawal from still face to reunion would likely support mothers' efforts to engage socially with their infants. In the current report we replicate and extend this work in an independent sample. Specifically, we attempt to **replicate** the work but with coherence of mind as assessed via the Adult Attachment Interview (AAI) as the measure of mothers' secure adult attachment. We **extend** the work by (a) considering AAI dismissing and pre-occupied dimensions as predictors of dynamic change in

physiology across the Still Face, (b) examining dynamic change in both RSA and skin conductance level (SCL), an indicator of physiological arousal, and (c) extending the model to determine if dynamic change in physiology is associated with higher maternal sensitivity.

Participants were 259 primiparous mothers (51% Black) and their infants (51% female). Expectant mothers completed the AAI in their 3rd trimester. The coherence of mind rating was maintained and the dimensional approach was used to created continuous scores for dismissing and preoccupied states of mind (Haltigan et al., 2014) with coherence excluded. When infants were 6 months old, mothers and infants participated in the Still Face Procedure, and maternal heart rate and skin conductance were recorded. RSA was derived from heart rate (Porges, 1985). Infant affect (a covariate) and maternal sensitivity were rated during each Still Face episode. Latent growth curve analyses were conducted in MPLUS.

Coherence of mind did not predict dynamic RSA change (i.e., slope) across the still face, nor did it predict mean level RSA (intercept). However, coherence predicted higher SCL intercept (β = .26, p = .00) and marginally higher slope across the Still Face (β = .47, p = .07). There were no significant effects in relation to sensitivity during the re-engagement episode in this model. When specific insecurity dimensions were considered, the dismissing dimension predicted lower SCL intercept and slope (Figure 1). Moreover, there was a significant indirect effect from dismissing state of mind to lower maternal sensitivity via SCL slope. That is, mothers with more dismissing states of mind demonstrated lower overall arousal and less dynamic change in arousal across the Still Face (Figure 2), and lower dynamic change in SCL predicted lower sensitivity during the re-engagement episode. The preoccupied dimension was not a significant predictor.

Although the pattern varied from Xu and Groh (2023), the results support the view that adult attachment predicts dynamic variation in maternal physiology during stressful parent child interactions, and this in turn has implications for maternal sensitivity. Further, maternal arousal is not maladaptive in relation to parenting in some circumstance (Dix, 1991).

P3-H-625 - To follow or not to follow: the influence of emotion consistency on infants' social learning

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Details

In the early months of life, infants actively engage in learning from others to navigate their physical and social environment. Emotions can serve as important social cues to shape infants' learning experiences (e.g., Chiarella & Poulin-Dubois, 2018; Poulin-Dubois et al., 2011). However, prior research has primarily focused on exploring infants' learning from some stable traits and capacities (e.g., personality, conventional information, Stenberg, 2013; Colomer & Woodward, 2023). Even within the emotion domain, emotional signals were used to indicate a more or less dichotomous appraisal of a given situation. In real life, informants' emotions can change quickly from time to time. For instance, a person might enjoy a book in the morning but lose interest in it by the evening. The complexity of emotion sets it apart from other social cues discussed above. Given it is unknown if this complexity of emotion has

consequences for infants' subsequent learning, the current study aimed to explore how the consistency of emotional signals from one informant biases infants' gaze following and imitation.

Infants aged between 12 to 18 months (*N* = 19; 3 females) and 18 to 24 months (*N* = 19; 3 females) participated in the study. They watched videos of a female actress demonstrating positive or negative expressions (facial, verbal, & gestural) towards two novel objects. In the *Emotion Consistent* condition, the actress always showed positive expressions to one object and negative expressions to the other object. Following the learning phase, infants' social engagement was measured by their tendency to follow the gaze of this actress and to mimic this actress's behaviour (tuning on a light with the forehead). Additionally, we examined infants' social engagement with another actress with unstable/inconsistent emotional feedback in the *Emotion Inconsistent* condition. In the learning phase, another actress showed positive expressions towards another two novel objects in 50% of the trials and negative expressions for another half of the trials (Fig.1). We predicted that emotion consistency would impact how infants learn from the informant. Infants would be more likely to follow and mimic the actress who showed consistent emotional signals.

We first calculated infants' mean proportional looking times towards the gaze-cued side of the screen in three time windows after the actress shifted her gaze. The results showed that in the consistent condition, old infants allocated significantly longer time (*M* = 95.65%, *SD* = 20.85%) to look at the location where the actress directed her gaze during the first time window than in the inconsistent condition (*M* = 81.82%, *SD* = 39.48%; *p* = .029; Figure 2A). Additionally, we also calculated the proportions of infants who followed the actress's gaze to assess individual performance. The results revealed more infants followed the gazed-at direction in the consistent condition than in the inconsistent condition (*p* = .025, Figure 2B). Lastly, we coded infants' imitation behaviours and found no significant difference between the two conditions. These primary findings implied that infants are selective learners, they can rely on the consistency of emotional signals to understand their social world.

P3-I-627 - Growing into parenting together: Similarities and differences in parenting practices among first-time parents

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Details

Introduction: Parenting practices are important predictors of children's socioemotional and cognitive development. Children benefit in their development when parents function well as a team. One of the contributing factors is the extent to which parents share values, attitudes, and behaviors regarding parenting practices. However, most studies have relied exclusively on mothers' reports of parenting. Here, we examine the factors contributing to similarities and differences in the parenting behaviors of mothers and fathers within the same family and how accurately parents perceive and assess their partner regarding their parenting practices during the first three years of the child's life. **Methods:** We recruited 244 Swiss-German couples who were first-time parents, living together, and had an only child at 12, 24, or 36 months (+/- 3 months). Both mothers and fathers completed an online survey on parenting practices, including a self-assessment and an assessment of their partner's parenting practices. In addition, we assessed demographic variables such as education level, age, and relationship satisfaction. **Results:** We ran an Actor-Partner Interdependence Model (APIM) for all four scales on parenting practices

(positive parenting, responsible parenting, authoritarian parenting, inconsistent discipline), see Figure 1. Both mothers and fathers perceived themselves as (very) similar to their partners regarding all four parenting dimensions. Overall, they exhibited modest to moderate accuracy in assessing their partner's parenting practices. Although mothers and fathers showed comparable levels of positive parenting, they tended to overestimate the similarity between their parenting behaviors. In a next step, we conducted Multigroup APIM analyses to determine whether the parameters differed between different groups of parents. Authoritarian parenting, responsible parenting, and inconsistent discipline differ in part significantly in parents with 2- and 3-year-old children. Parents with sons tended to demonstrate lower accuracy in assessing their partner regarding inconsistent discipline. Additionally, couples who reported higher levels of happiness perceived each other as more similar regarding positive parenting. **Discussion and Outlook:** Parents perceive themselves as similar in their parenting behavior towards infants and toddlers, but this can vary in the different parenting dimensions depending on relationship satisfaction, age, and child gender. In a preregistered follow-up study starting in December 2023, we examine the relationships between maternal and paternal parenting practices and child temperament. Previous research has shown bidirectional associations between parenting behaviors and child temperament. We hypothesize that positive, responsible, and authoritative parenting practices will be associated with higher levels of surgency and effortful control. Furthermore, we expect inconsistent discipline to be associated with lower scores on surgency and effortful control and higher scores on negative affectivity. Data analysis of the follow-up study will be completed in March 2024, and we will report this additional data at the conference in July 2024.

P3-I-628 - Infant empathic arousal in response to facial expressions of emotion: A cross-cultural pupillometry study

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Details

From birth, infants are sensitive to the emotions of others, as indicated by their self-distress responses when hearing the cries of another infant - an indicator of emotional contagion, which is considered a fundamental building block of empathy. Infant emotional contagion has been shown to be biased towards negative over positive emotions, and empathy is socially-biased towards individuals perceived as close, familiar, or similar. For instance, infants from around the second year of life are more likely to comfort their mothers in distress than an unfamiliar experimenter. However, it is unclear if this social bias occurs earlier in empathic development, at the level of emotional contagion, before the onset of explicit empathic behaviours. In this study, we therefore aimed to investigate the interplay of emotional valence and familiarity and their effect on emotional arousal as a sign of emotional contagion.
To do so, we used pupillometry, which measures changes of pupil dilation as a proxy for internal emotional arousal. We examined evidence for infant empathic arousal in response to emotional facial expressions across different emotional valences (happy, sad, neutral) and stimulus familiarity (unfamiliar ethnicity, familiar ethnicity, own mother). Additionally, we examined if these interacted with the infant's cultural background, based on the cultural display rules for specific emotions and different social structures of infants' environments which may affect how they interact with and perceive the emotions

of unfamiliar others. To address these questions, we tested a large cross-cultural sample of infants (N = 300) in three cultural settings: rural and urban Uganda and an urban setting in the UK. Infants aged 10-11 months viewed photos of emotional facial expressions (neutral, happy, sad), after a scramble image baseline, for which we used four different models to control for the effect of specific features of an individual model's facial expressions. The photos were either of female adults of their own ethnicity, another ethnicity, or their own mother.

Results revealed that infants showed differences in pupil dilation between sad and happy, and sad and neutral faces, indicative of empathic arousal in response to the emotions of others across sites. We found no differences in pupil dilation in response to emotions of the infant's own vs. an unfamiliar ethnicity. However, we did find that UK infants, but not rural Ugandan infants, showed greater pupil dilation in response to their mother's emotion expressions than to a same-ethnicity stranger. This may be related to the prevalence of distributed caregiving in rural Uganda, which places less focus on the mother as a primary caregiver, possibly weakening the empathic bias towards her.

Overall, using a cross-cultural approach to address a foundational question in early socio-emotional development, our results shed light on the mechanisms underlying infant sensitivity to the emotions of others. We show that although infants across all three cultural settings experience emotional arousal in response to others' states, the socio-cultural caregiving environment plays a role in shaping these empathic tendencies.

P3-I-629 - Impact of maternal mobile device use on infant affect depending on maternal behavior

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Details

Introduction: The prevalence of mobile device usage has increased, yet its impact on infant development remains unclear. Previous studies, such as Mac Daniel (2019), have explored the influence of parental phone use on maternal behavior (maternal sensitivity), child behavior (increased inappropriate behaviors, negative affects), and overall relationship quality. Some studies (Myruski et al., 2018; Stockdale et al., 2020; Rozenblatz-Perkal, 2022) have suggested a still-face paradigm effect resulting from parental phone use. Unlike these studies, our research concurrently examines maternal interactive behaviors and the infant's emotional state within a modified still-face paradigm involving phone calls or texts, allowing mothers to use their phones naturally while interacting with their infants.

Objective: This study aims to analyse the effects of technoference on infant's emotional state. We compared communication signals initiated by mothers before, during, and after technoference. Additionally, the study seeks to assess the impact of interaction disruptions caused by a call or text message during technoference or the reunion phase on the infant's emotional state. Specifically, the study investigates whether maternal communicative behavior (gaze, touch, etc.), mother's phone use habits, and technoference type (SMS or phone call), contribute to the infant's affective state during and after technoference.

Method: Forty mothers and their 6-month-old infants (mean age = 6.38; standard deviation = 0.39) participated in two interactive episodes corresponding to Free Play (1.5 min), Technoference (1.5 min),

and Reunion (1.5 min). Technoference episodes involved a text message or a phone call in a random order, simulating a conversation through SMS or vocal call with a sudden interruption of interaction. Video analysis using The Observer XT software was used to record gaze, vocalizations, facial expressions, and touches every 5 seconds, along with the infant's affective state. Coding reliability ranged from .63 to .90 (Cohen's kappa). Mother's phone use habits were recorded using an online questionnaire. The protocol was approved by the university ethics committee.

Results: Preliminary results from 29 mothers indicated a decrease in maternal gazes, facial expressions, and speech addressed to the child during mobile phone use. On the contrary, touches remained stable. The infant's average affective state also decreased during technoference and did not return to baseline during the reunion phase (See Figure 1).

Conclusion: Preliminary results indicated that maternal interactive behaviors were not uniformly impacted during technoference. Furthermore, phone call and SMS did not indice the same interference in dyadic communication. Consistent with Stockdale et al. (2020), the infant's affective state was persistently affected after technoference, regardless of the modality (phone call/SMS). Further analysis will determine if maternal communicative behavior explains differences in the infant's affective state during technoference more than phone use habits.

P3-I-630 - Distinct profiles of maternal mental health and household chaos predict individual differences in infant emotional reactivity and regulation

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Details

Introduction: maternal depression, anxiety, and stress are associated with differential emotional development in infants. In addition, there is growing evidence that household chaos is an environmental stressor that may have compounding effects on infant outcomes. However, virtually all research in this area has examined these issues using variable-centered approaches, which assume that associations among variables within a population are homogonous. To better capture the heterogeneity of infants' early environments, we use latent profile analysis to examine how distinct *patterns* of maternal mental health and household chaos may differentially predict infant outcomes.

Method: Data was collected from N = 188 6-month-old infants and their mothers. Infant emotional reactivity and regulation were evaluated using the Still Face and Arm Restraint tasks, which were conducted in the home using remote Zoom assessments. Maternal psychosocial stress was assessed using the Perceived Stress Scale (PSS), and symptoms of depression and anxiety were measured using the Edinburgh Postnatal Depression Survey (EPDS). Aspects of household chaos (disorder/commotion and routines/structure) were assessed using the Chaos, Hubbub, and Order Scale (CHAOS).

Results: Latent profile analysis was used to identify distinct profiles of mother-infant dyads using maternal mental health and household chaos as indicators. A 3-profile model was the best fitting model, determined by having the highest entropy value (.81 vs. .78 and .75 in the 2- and 4-profile models) and

the lowest Bayesian information criterion (1407 vs. 1430 and 1410 in the 2- and 4-profile models). The identified profiles were: (1) a low stress/low chaos profile, who had below-mean EPDS, PSS, and household chaos scores; (2) a moderate stress/low chaos profile, who had elevated EPDS/PSS scores and low household chaos scores; and (3) a high stress/high chaos profile, who had high EPDS, PSS, and household chaos scores. We then examined whether membership in a particular profile was associated with differences in infant emotional regulation using the BCH procedure, which accounts for measurement error associated with most-likely profile membership. Results indicated that infants in the moderate stress/low household chaos profile showed higher negative affect during the still face phase than infants in the high stress/high chaos profile, $c^2 = 6.11$, $p = .01$. In addition, relative to infants in the moderate stress/low chaos profile, infants in the high stress/high chaos profile demonstrated greater self-comforting behaviors during still face, $c^2 = 3.97$, $p = .04$, and greater recovery from distress in the arm restraint, $c^2 = 3.80$, $p = .05$, and still face tasks, $c^2 = 10.50$, $p = .001$.

Conclusion: These findings demonstrate that distinct patterns of maternal psychosocial stress and household chaos have differential effects on infant outcomes. In contrast to prior findings using variable centered-approaches, our use of a person-centered approach indicated that distinct patterns of maternal psychosocial stress *combined* with household chaos was associated with differential emotional regulation behaviors. These findings indicate the importance of considering the heterogeneity and complexity of infants' early environments in shaping developmental processes, and raise novel insights into how infant emotional regulation may be adapted to the unique characteristics of the early environment.

P3-I-631 - Complementary feeding and maternal responsiveness in 8 to 24-month-old infants: a longitudinal study

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Details

In many Western countries, infants are traditionally introduced to solid foods through spoon-fed pureed foods (parent-led weaning [PLW]), but an alternative approach known as "baby-led weaning" (BLW) has become increasingly popular. With BLW, children participate in family meals and, when they show interest, caregivers provide food that they can eat independently.
We have recently shown that maternal responsiveness to receptiveness and fullness cues correlated at 8, but not at 12 months. Moreover, mothers were more responsive to infants' receptiveness than fullness cues, possibly due to an evolutionary drive to protect infants from starvation. Furthermore, responsiveness to fullness, but not to receptiveness, was positively related to the proportion of infant self-feeding.

Here, we investigated the relationship between the complementary feeding approach and maternal responsiveness to receptiveness and fullness cues in 156 Italian children observed at 8, 12, 18 and 24 months of age. Mothers reported the complementary feeding method used (PLW, BLW, or mixed), and provided demographic information. Moreover, at each time point we recorded one meal for each child, from which we coded the proportion of self-feeding and rated maternal responsiveness by means of the Responsiveness to Child Feeding Cues Scale (Hodges et al., 2013).
Random-effects ordered logistic regressions showed that mothers were more responsive to receptiveness when their child was 12- ($z = -2.99$, $p = .003$), 18- ($z = -2.26$, $p = .024$), and 24 months old ($z = -2.21$, $p = .027$) than when 8 months old, but there were no other significant age differences. Regardless of age there was a significant effect of (i) gender, with mothers of females being more responsive than those of males ($z = 2.50$; $p = .012$), (ii) feeding method, with mothers employing baby-led weaning being more responsive than those employing parent-led weaning ($z = 1.99$; $p = .047$), (iii) exclusive breastfeeding duration, which was negatively related with maternal responsiveness to receptiveness ($z = -2.34$; $p = .020$). Mothers were more responsive to fullness when their child was 12- than 8 months old ($z = 3.22$; $p = -001$), and 18- than 12 months old ($z = 5.90$; $p < .001$), but responsiveness to fullness decreased between 24- and 18 months old ($z = -2.58$; $p = .010$). Regardless of age, responsiveness to fullness was positively related to proportion of self-feeding ($z = 3.68$; $p < .001$). Thus, maternal responsiveness to receptiveness was higher in girls than boys and in children breastfed for a lesser amount of time, whose mothers may have been more concerned children were not eating enough. Regardless of the complementary feeding approach, responsiveness to fullness, but not to receptiveness, decreased at around two years of age, probably as a maternal attempt to counteract child neophobia, which usually peaks at this time. Finally, a complementary feeding approach alternative to parent-led weaning was related to more infant-centered maternal responses both at the beginning and at the end of the meal, with potential implications for better infant self-regulation and possibly socio-emotional development beyond the weaning period.

P3-I-632 - Parent-child conversations about discrete emotions: Exploring parent emotion coaching

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Details

Emotions are an integral part of human experience, and learning how to navigate them effectively is a fundamental life skill. Parents play a pivotal role in this emotional education. Through ongoing conversations and interactions, parents transmit not only their values but also their strategies for handling emotions. This study examined the strategies that parents used to coach their children about discrete emotions.

Parents and their two-and-a-half year old children (N = 236) looked at a picture book with 10 discrete emotions (joy, sadness, fear, anger, disgust, shame, embarrassment, awe, guilt, and pride). Parent talk was coded for four emotion coaching strategies based previous research: seeking external support, stimuli/elicitor focused coping, emotion focused coping, and softening. Parents provided emotion coaching on 23% of pages and GLMMs indicated that they varied use of strategies across discrete emotions (ps > .01). Table 1 presents corrected pairwise comparisons across strategies and emotions.

Within each emotion, parents provided emotion coaching strategies the most for shame (47%), alongside fear (43%) and guilt (39%). Within each emotion coaching strategy, 7% of parents suggested "seeking external support" for sadness, 25% of parents suggested "stimuli/elicitor focused" coping for fear, 9% of parents suggested "emotion focused" coping for guilt, and 23% of parents suggested "softening" for shame.

This study highlights the different emotion coaching strategies that parents use when teaching their children how to respond and cope with discrete emotions. The findings underscore the variability in the strategies that parents use, elucidating how parents tailor their coaching strategies to the specific emotions presented. Our next steps are to look at gender differences between how parents coach emotion strategies to boys versus girls. Furthermore, given the longitudinal nature of this study, we want to examine longitudinal changes in emotion coaching that may occur between the first wave and subsequent waves. Additionally, we want to investigate as the children get older if they provide more emotion coaching strategies. Finally, we want to investigate any differences in socioeconomic status and culture that may explain why parents use one strategy more than another strategy.

P3-I-633 - Exploring stability and individual trajectories in neonatal reactivity and regulation: Insights from a longitudinal study

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Details

Background. Newborns rely on coordinated and synchronised internal systems to effectively process sensory information and regulate their behaviour. Conversely, suboptimal regulation and reactivity in infancy correlate with temperamental challenges in the later stages of childhood (Lean, Smyser, and Rogers, 2017). Identifying neonatal markers of heightened reactivity and poor regulation is clinically crucial for timely support to promote infant health and caregiver relationships. While studies highlight links between Neonatal Behavioural Assessment Scale (NBAS) (Brazelton & Nugent, 2011) scores and future temperament and developmental outcomes, continuous measurements over the first weeks of life are necessary to ascertain whether relevant scores change with maturation or are influenced by other factors. This study aims to assess neonatal reactivity and regulation longitudinally, drawing on a novel two-factor structure from a subset of NBAS items.

Methods. Thirty-four term-born infants from an ongoing Perinatal Imaging in Partnership with Families (PIPKIN, www.pipkinstudy.com) project were assessed up to three times: prioritising, where possible, a home visit around 1 week, 2 weeks and 1 month of age. Excluding individual datasets that could not be scored on regulation and reactivity items, participants who contributed data for the current study were aged 2-10 days (N = 14), 9-18 days (N = 14), and 26-45 days (N = 21). A linear mixed-effects model analysed change in average regulation and reactivity scores over three sessions. The Intraclass Correlation Coefficient (ICC) assessed individual factor score similarity across time points. Pearson correlation

assessed relations between factor scores across any two sessions and within each session. Linear regressions estimated gestational age and infant age effects on factor scores at each time point.

Results. Results revealed stability of mean regulation and reactivity scores across the three time points, with significant individual variability in regulation scores (ICC = 53.2%). Notably, there were no significant between-subject differences in the reactivity scores across sessions. A significant correlation was observed between sessions 2 and 3 regulation scores (r = .66, p = .03), and a trend between sessions 1 and 2 (r = .59, p = .09), while no significant correlation was observed between reactivity scores. A more optimal reactivity was associated with better regulation only at the first session (r = .64, p = .01). Factor scores were not explained by infant age at any session. Gestational age at birth predicted lower regulation scores at session 3 for earlier births (R^2 = .40, F(1,19)=14.37, p = .001). No significant relationship was found between gestational age at birth and neonatal reactivity.

Conclusions. Stability in regulation and reactivity scores, along with moderate between-subject variability in the regulation scores, support the proposed regulation factor structure's utility in measuring dispositional traits. The lack of individual variability in reactivity may suggest that chosen items do not capture individual differences fully. Further analysis with a larger sample is warranted to confirm these results. While data collection is ongoing, these results may offer a reliable method to assess neonatal regulation.

P3-I-635 - Associations between infants' temperament and frequency of regulatory and instrumental media uses

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Details

Children under two years old spend about two hours each day using screen media (Rideout & Robb, 2020). Previous work links children's temperament and socioemotional development with media use. Parents of infants exhibiting more challenging behaviors and temperaments report that their infants spend more time using screens (Linder et al., 2020), and children's externalizing behaviors have been associated with more media use later in childhood (McDaniel & Radesky, 2020). While these associations have been examined for some socioemotional skills, it remains unclear how infant temperament is related to the reasons children use media.

The reasons that parents use media with their children are important for considering interventions supporting parenting needs and goals. In addition to managing behaviors with media, parents employ screens as a strategy for keeping their children occupied while working or doing chores (Nikken, 2019).

Clarifying the reasons parents use media in relation to their infants' temperament may inform practical guidance for parents when making these decisions.

This study examines the relation between child temperament and reasons that parents use media with their children for regulating emotions and behavior (RQ1) and instrumental reasons (e.g., learning; RQ2), holding constant demographic characteristics. We hypothesized a positive association between negative affect and using media for regulation. Additionally, we predicted a negative association between effortful control scores and instrumental media use.

Participants were 245 parents (88% mothers) of 12- to 23-month-old children (mean age = 17 months). Parents were predominantly white (65%) and college educated (91%). This study focused on the CAFE Media Assessment Questionnaire (MAQ; Barr et al., 2020) and Early Childhood Behavior Questionnaire Very Short Form (ECBQ-VS; Putnam et al., 2011). The outcomes, frequency of use for regulatory and instrumental reasons, were derived from a factor analysis of items in the reasons for media use with children scale (RUM; Suh et al., 2023).

Bivariate OLS regressions showed that negative affect was positively associated with both children's regulatory and instrumental media use. A one-point increase in children's negative affect was associated with a 0.44-point increase across regulatory uses and 0.29-point increase across instrumental uses on a 1-to-5 scale, holding constant demographic characteristics (Table 1).

Negative affect was more strongly associated with regulatory uses of media. Children with higher negative affect experience greater discomfort, fear, and sadness and are less easily soothed. Media may be a strategy for parents comforting a frequently upset toddler who is difficult to soothe. Negative affect was also associated with instrumental media uses, such as occupying a child and bonding together. Other aspects of negative affect include shyness, motor activation, and perceptual sensitivity. For children with heightened levels of these characteristics, screens may be tools for connecting with others and being occupied while parents work. These results are consistent with previous findings of using media to calm children with poorer socioemotional skills (Radesky et al., 2016), and including instrumental media extends studies of media reasons. Future analysis of a 6-month follow-up will allow us to determine whether these between-person trends hold when compared within-person.

P3-I-636 - Multilevel associations between parents' daily reports of infant mood, reasons for family media use, and parenting behavior

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Details

Parents report using media to manage their own and their child's emotions (Nikken, 2019), explaining why characteristics such as parenting stress and child temperament predict both parent and child media use (Coyne et al., 2021; McDaniel & Radesky, 2018, 2020; Radesky et al., 2014). However, prior research relies on global estimates, overlooking day-to-day fluctuations in families' experiences. The present study used daily diaries to measure parent-reported infant mood, reasons for media use, and parenting

behavior. We expected different same-day associations to emerge depending on the reasons for media use on a given day.

A sample of 199 predominantly white (71%), college-educated (91%) parents (93% mothers) of an infant 11-24 months old reported infant mood, family media use, and parenting behavior for 21 days. Mood items captured infants' negative affect (e.g., fussy, whiny, mad) and positive affect (e.g., happy, content). Media items captured the frequency of parents' media use to self-regulate (e.g., mentally "check out" or escape), regulate their child (e.g., calm big emotions), relax alone, or relax with their child. Parenting items captured negative behaviors (e.g., yelling) and positive parenting (e.g., soothing, praising).

A multilevel structural equation model controlled for the amount of time parents spent with their infants each day. Within-person effects illustrate same-day associations comparing parents to themselves, whereas the between-person effects illustrate associations comparing parents to each other.

Within-person effects (Figure 1) showed that associations between infant mood and media use did not depend on the reason for media use. On days when parents reported elevated infant negative affect or positive affect (compared to their own average), they also reported elevated media use for all four reasons. However, same-day associations between media use and parenting behavior did differ by media reason. Using media more often than usual to self-regulate (compared to their own average) predicted higher-than-average negative parenting the same day, whereas using media to regulate the infant predicted less negative parenting that day. Conversely, using media to relax alone or together predicted higher-than-average positive parenting the same day.

Between-person effects (Figure 2) revealed fewer, and in some cases different, associations. Parents who reported more infant affect (both negative and positive) on average reported more media use to relax alone or with their infant, compared to other parents. Parent-reported infant negative (not positive) affect also predicted self-regulatory media use. In turn, higher self-regulatory media use predicted more negative parenting, whereas higher media use for parent relaxation predicted less negative parenting compared to other parents.

Overall, these data show that day-to-day fluctuations in parent-reported infant mood predict use of media to meet several parenting goals. Further, same-day associations between media use and parenting behavior differ depending on the reasons media were used, with self-regulatory media use predicting more negative behavior and media for relaxation predicting more positive behavior. Different patterns emerged when comparing parents to each other (between-person effects) than when considering day-to-day fluctuations (within-person). Ultimately, understanding how parents use media on a day-to-day basis can illuminate new targets for intervention.

P3-I-637 - Experiences of parents and maternity services professionals during and after the COVID-19 pandemic

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Details

Interactive behaviors between parents and their infant begin immediately following birth, as newborns are inherently interactive and strive to form affectionate ties through the primary forms of contact, ensuing within gaze and touch behaviors (Egmose et al., 2018; Feldman et al., 2007). Through these early sensory experiences, parents and their infants form an affectionate bond, with adaptive caregiving practices tied to healthy patterns of infant brain development (Hardin et al., 2021). In addition, many support practices standardly offered by maternity services professionals, particularly breastfeeding support, rooming in, and skin-to-skin contact, increase affectionate-bonding behaviors in the parent-infant dyad (Crenshaw, 2014). Families, with the assistance of maternity services professionals, strive to provide the necessary care during birthing and the days following childbirth. However, COVID-19 disrupted the lives of many families in many ways, especially in newborn care. Using a mixed methods, qualitative design, our study aimed to document the perspectives and experiences of families and maternity service professionals regarding the pandemic's influence on newborn care practices.

Initially, data were collected from 2020 to 2021 from multiple public domains. This included postings from blogs, websites, chat rooms, and publicly published documents regarding the labor, delivery, and neonatal stages of the birthing experience. A total of 150 narratives were reviewed. Conventional content analysis (Hsieh & Shannon, 2005) was performed, where several researchers noted initial impressions of the posts, labeled the posts for codes, sorted them into subcategories, combined subcategories into categories, and defined the categories as themes.

A second round of data was obtained during 2023 via questionnaires (demographic and depression scores via the Center for Epidemiological Studies-Depression Scale, Radloff, 1977) and semi-structured interviews, focusing on themes that emerged from the initial data collection. Interviews were conducted either in-person, by telephone, or virtually through a video conferencing platform. The goal of these interviews was to capture the complexity and diversity of the participants' lived experiences and emotional reactions. Analysis of the interviews are meant to provide important information when reviewed for themes and discourse outcomes, including investigating those with higher depressive symptoms compared to those with few depressive responses post-pandemic.

Results of the initial document collection yielded themes with both positive and negative experiences from parents and maternity services personnel. In general, four themes emerged (See Table 1): Altered Care, Keeping Safe, Emotional Upheaval, and Striving to Adapt.

Ultimately, the narratives demonstrate significant emotional and psychosocial effects due to the pandemic. However, both groups adjusted their caregiving and caretaking practices to support the mother-infant dyad. Families adapted and were supported as needed (Foye et al., 2021).

The narratives and subsequent interviews reviewed further have implications for the development of hospital, health care, or social policies. Striving to maintain interpersonal connections remains important despite barriers presented by the pandemic. By being authentically present and coming to know each other, maternity services professionals can recognize calls related to emotions and safety to co-create professional and empathic responses, as affiliative bonds leading to attachment are influenced and established at early developmental periods (Diamond et al., 2020).

P3-I-638 - Cognitive and socio-emotional development of children whose mothers had Gestational Diabetes Mellitus: A secondary analysis in Singapore

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Details

Background: Reports have shown an increase in Gestational Diabetes Mellitus (GDM) incidence. GDM affects between 1% and 30% of pregnancies worldwide and is particularly prevalent among Asian women. A recent report in Singapore shows that GDM prevalence is 23.5% 9 (IDF Diabetes Atlas 9th edition Singapore Diabetes Report). GDM can cause pregnancy difficulties, birth complications, and long-term chronic conditions such as cardiometabolic disorders and Type 2 Diabetes (T2D) in both mother and offspring. Also, as a result of GDM, there is an additional risk to the embryo, foetus, and pregnancy course that may adversely impact early cognitive and socio-emotional development and childhood body composition, contributing to high childhood obesity rates in the population. In addition, studies have shown that the GDM may impact motor and behavioural neurodevelopmental outcomes, increasing neuropsychiatric morbidity (e.g., deficit attention and hyperactivity, autism spectrum disorder), in the toddler and pre-school child. With the growing incidence of GDM, understanding its effects on early child development may improve the health and development of future generations. **Objective:** The aim of this study is to assess the cognitive and socio-emotional developments in children with a mother with GDM history. **Method:** The study is a secondary analysis of an ongoing study called: "Harnessing humAn Potential and imProving health sPan in women and their children: a Randomized Controlled Trial (RCT) and follow-up (HAPPY study)" registered in ClinicalTrials.gov [NCT05949957]. The Happy study consists of the effectiveness of lifestyle interventions in preventing diabetes in Asian mothers with a history GDM. Cognitive and socio-emotional assessments were collected on their toddlers and pre-school children between the ages of 3 months and 10 years old. During baseline visit post-GDM mothers were asked to complete a sociodemographic survey of their child. Furthermore, the following questionnaires were completed: (a) developmental screen (ASQ-3) to assess the progress in communication, gross motor, fine motor, problem solving and personal-social; (b) Cognitive Home Environment Questionnaire (StimQ Toddler/Pre-school); (c)The Behavioural and Emotional screening system (BASC-3), and (d) the Behavioural Rating Inventory of Execute Function (BRIEF2). This research is a descriptive study of those collecting children's questionnaires. **Results:** This is an ongoing study; we will present a descriptive outcome regarding cognitive and socio-emotional developments of those children. The Statistical Package of Social Sciences (SPSS), version 26.0 will be used for computerized data entry and analysis. Descriptive statistics will be performed (frequency and percentage). To test the significance of differences between cognitive and socio-emotional development screen and normal children, c 2 will be applied. A significant statistical level will be considered when the p-value < 0.05. **Discussion:** The impact of post-GDM woman in their children's socio-emotional and cognitive development should be viewed with caution. The study may support the understanding of GDM impact in the development child, and the consideration for improve interventions with the population (Mother and child). However, more studies involving larger populations are required to identify the effects and impact of that condition on the toddler and preschool child, considering the rise of GDM worldwide.

P3-I-639 - EEG coherence dynamics in infancy: Bio-marker correlates reflective in temperament and electrocortical development

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Details

Temperament and its development have been associated with alpha band EEG coherence in previous research that focused on adolescent and adult populations (Bowyer, 2016; Srinivasan et al., 2007). Investigating cortical correlates in infancy, specifically coherent system trajectories measured though functional connectivity, could reveal meaningful influences that could span the rest of development. Previous research suggests that EEG coherence stands as a reliable indicator of emotional states (Ekman & Davidson, 1993; Kostyunina & Kulikov, 1996; Nie et al., 2011). In our analyses, we primarily explored if resting-state alpha coherence measures differ in various brain regions and are associated with variation in temperament and its development. We expected an association between negative affectivity and greater right hemisphere anterior EEG coherence but also explored other temperamental traits, including positive affectivity, activity level and emotion regulation. As a secondary, developmental hypothesis, we investigated whether EEG coherence in infant alpha frequency bands increased (specifically, in frequency band definitions and from posterior to anterior), in accordance with theories of neurophysiological development. The sample consisted of 203 healthy full-term infants across five data sets (101 males, 101 females, and 1 non-specified; 164 Caucasian, 8 Hispanic, 7 Black, 24 non-specified) with infant age ranging from 3- to 12-months. Resting-state EEG alpha-band coherence in nearby pairs was measured across frontal to occipital regions and measures of temperament were also obtained from maternal-reported Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein et al., 2003) at each age. Infant alpha may be displayed in different frequency bands across age categories; therefore, EEG was analyzed utilizing two standard infant frequency bands, 3-6Hz and 6-9Hz (as infant power changes across the frequency spectra with age (Bell & Cuevas, 2012; Hardin et al., 2021) and as a means to understand their respective synchrony with temperamental qualities. Regression analyses suggested that the negative affectivity temperamental qualities did not significantly predict EEG coherence, $p > .05$. However, repeated-measures, exploratory analyses showed that reactive temperament types, in particular, positive affectivity F (5, 925) = 75.16, $p < .001$, $\eta_p^2 = .68$, activity level F (5, 925) = 75.88, $p < .001$, $\eta_p^2 = .68$, and emotional/self-regulation F (5, 925) = 76.37, $p < .001$, $\eta_p^2 = .68$, were evident in those that had significantly higher coherence pairs within posterior regions. Further the secondary hypothesis analyses yielded significant results in favor of the electrocortical development hypothesis (Figures 1 & 2) with higher coherence in posterior pairs than anterior pairs across both alpha frequency bands. Overall, the main findings support the latter hypothesis, which argued that as age increases (from 3- to 12-months), a synchronous result in coherence may be seen specifically from posterior to anterior regions, which align with theories of neurophysiological development (Miskovic et al., 2015). The findings indicate consistent developmental trends within the alpha frequency band but suggest the need for further studies of temperamental dimensions that are associated with dynamic alterations in development across age.

Keywords: Temperament, Development, Coherence, Infants, Alpha, Negative affectivity

P3-I-640 - Links between maternal trauma, response to distress, and toddler internalizing and externalizing behaviors: A mediational analysis

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Details

Previous research shows that mothers' experiences of trauma are linked to their child's later socioemotional functioning (Lambert et al., 2014), however, the mechanisms involved are not well understood. One potential mediator is maternal insensitive responses to child distress (Cummings & Davies, 2002; Luebbe et al., 2011; Eisenberg et al., 1999). This study examined the link between maternal trauma, mothers' responses to toddler distress, and toddlers' socioemotional outcomes among a socioeconomically diverse sample of 110 mothers and their 12- to 35-month-old toddlers. It was hypothesized that a mother's difficulty in responding sensitively to her child's distress would mediate the relations between maternal trauma and child internalizing and externalizing behaviors. Two mediational models were tested to examine non-supportive responses to distress as a potential mediator of the relation between maternal trauma and toddler mental health outcomes; one model focused on predicting child internalizing symptoms and the other focused on predicting child externalizing symptoms. Measures included assessment of maternal trauma (Life Stressor Checklist-Revised; Wolfe & Kimerling, 1997), mothers' responses to child distress (Coping with Toddlers' Negative Emotions Scale; Spinrad et al., 2007), and toddler socioemotional functioning (Infant-Toddler Social and Emotional Assessment; Briggs-Gowan & Carter, 1993). Results revealed that the relations between maternal trauma and toddler symptoms (internalizing and externalizing symptoms) were mediated by maternal non-supportive response to child distress for both internalizing and externalizing domains of child mental health. Findings suggest the importance of early intervention for trauma-exposed mothers and target areas for parenting interventions.

P3-J-642 - Knowledge and attitudes of early interventionists surrounding drugs and drug problems

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Details

Introduction:

There is a growing recognition of the need to develop early interventionists' (EIs) knowledge and attitudes surrounding drugs and drug problems to enable them to deliver effective care for families of infants with prenatal drug/substance exposure.

The use of opioids in the United States has increased dramatically over the past two decades and has disproportionally impacted the Appalachian region (NACO & ARC, 2019). Children born with drug-

exposure are eligible to receive services through the Tennessee Early Intervention System, a program that offers services at no cost to families, including weekly developmental therapy with an EI. Given the regularity in which EIs in Tennessee are expected to be working with substance-exposed infants and their families, it is important to understand the attitudes and knowledge of EIs.

Purpose: The purpose of the current study was to understand the experiences, practices, needs, and preparation of EIs related to infants and young children with prenatal substance exposure and their families.

Methods: An online survey was developed and distributed to the target population of all credentialed EIs (excluding SLPs, OTs and PTs) who deliver services across the state of Tennessee, United States. The finalized survey included several items developed by the research team but also several standardized surveys. This abstract focuses on the Drug and Drug Problems Perception Questionnaire (DDPPQ; Watson et al., 2006) and an adapted version of Perceptions of Working with Families in Poverty survey (Corr et al., 2020).

One hundred and twelve EIs completed the survey. Participants were mainly female (96.7%), on average, 41 years old, with 0-2 years of involvement with EI services. Most respondents worked in community-based EI programs for young children with disabilities (71.4%), were employed by a non-profit organization (58.2%). The highest degree for most respondents was a bachelor's degree (59.3%). On average, participants had 20 families on their caseload with about 24% including infants with PSE. A random sample of 20 participants will be selected for semi-structured interviews scheduled to take place during Spring 2024. Data will be ready for presentation in July.

Results:

The results of EIs experiences supporting infants and children with prenatal substance exposure and their families is presented in Table 1.

EIs perceptions and attitudes related to drugs and people who use drugs are summarized in Table 2. Data indicate that the average EI in the state of Tennessee is either not sure whether they agree or disagree or "somewhat agreeing" with the presented statements related to drugs or people who use drugs.

Conclusion:

Given the high prevalence of substance use in the United States and specifically in Appalachia it will be important to develop trainings targeting knowledge and attitudes surrounding substance use. This additional education will further empower and increase the confidence of EIs when working with infants and children with prenatal substance exposure and their families. While the current study is limited to developmental therapists within the state of Tennessee, it is our hope that future research will extend to other states and other professionals working within the EI setting.

P3-J-643 - Gahvora's embrace: Effects of cradling on nighttime waking in Tajik Infants

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Details

Sleep is critical in early development. Across multifarious cultures around the world, there is no clear standard or consensus about effective ways of putting infants to sleep and maintaining quality sleep. Parents around the world have developed various approaches to the childrearing practices of sleep (i.e., rocking, co-sleeping, bed-sharing, breastfeeding to sleep and so on). Maintaining sleep quality—fewer night wakings—is especially important because of the well-documented link between sleep quality and learning in infants and adults. Moreover, parents look forward to and appreciate when their babies finally sleep through the night. Less is known about the cultural factors that are associated with maintaining sleep. We focused on sleep practices in Tajikistan, where caregivers use a traditional gahvora cradle from birth to 2-3 years. In the gahvora, infants are tightly swaddled from head to toe and bound to the gahvora to keep infants from falling out while the cradle is rocked. Aside from its tradition and history, caregivers champion the practice for promoting and maintaining sleep, allowing parents to attend to chores or other children.

We asked whether gahvora cradling keeps infants asleep as Tajik caregivers claim. To do so, Tajik caregivers (*N*=340) of infants 1 to 24 months of age were interviewed. A local Tajik researcher collected 543 time diaries in which caregivers reported the time and place of infant sleep throughout the previous 24 hours, instances of night waking, and the time spent awake for the day.

We hypothesize that regardless of age, infants who sleep in the gahvora will have fewer nighttime wakings compared to infants who sleep in other settings—specifically, co-sleeping with parents on a thin floor mat. Perhaps the tight gahvora swaddles prevent startling, keeping infants asleep, comfortable, and warm. Alternatively, it is possible that nighttime wakings will also remain low for infants who co-sleep with parents.

Preliminary data from 49 infants aged 1 to 24 months revealed that 65% of infants slept in the gahvora for the entire night; 21% slept with a parent on a thin floor mat. The number of night wakings was stable across the two locations but decreased in frequency with age. Some infants (14%) were put down for the night in one location (e.g., gahvora) but moved in the middle of the night (e.g., with parents). Data coding and analysis are ongoing. We plan to compare the frequency of night wakings in infants who remain in the same location throughout the night to those who change their sleep locations. Moreover, we will examine sleep location patterns to reveal the effect of Tajik child-rearing practices on sleep quality

This study aims to consider the role of culture and childrearing practices on infant sleep quality which will serve as a crucial step toward informing caregivers and promoting optimal sleep health for infants.

P3-J-644 - The development of preterm infants from low SES families: The combined effects of melatonin, autonomic nervous system maturation, and psychosocial factors (ProMote)

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Details

Objective: The main aim of this study is to investigate the association of certain psychosocial (e.g.maternal mental health, family functioning, perceived social support and dyadic coping and others) and biological factors (maternal derived-melatonin through breastfeeding and heart rate variability) across the first year of life of preterm infants' development, with focus on low socio-economic status families.

Methodology: The conceptual framework of the described work is summarized in the attached figure:

Maternal depression, at birth, will be assessed with the Edinburgh Postnatal Depression Scale (EPDS, Cox, 1987) while maternal depression, at 6 months, will be assessed with The *Beck Depression Inventory-II* (BDI-II; Beck, 1996). The *Spielberger State-Trait Anxiety Inventory for Adults* (STAI, Spielberger, 1983) will be used to measure maternal anxiety. The *Family Adaptability and Cohesion Evaluation Scales IV Package* (FACES IV; Olson, 1979; Olson, 2019) will be used to assess perceived family functioning. The *Multidimensional Scale of Perceived Social Support* (MSPSS, Zimet, 1988) will be used to assess the perception of maternal social support. The *Dyadic Coping Inventory* (DCI, Bodenmann, 2008; Ledermann, 2010) will be used to measure dyadic coping behaviors. The *Maternal Perception of Infant's Intersubjectivity Questionnaire* (MPIIQ, Carrulo, 2022) will be used to assess maternal perception of the infant's intersubjectivity. The *Maternal Postnatal Attachment Scale* (MPAS, Condon & Corkingdale, 1998) will be used to assess mother's subjective feelings of attachment to her infant.

Mothers of preterm neonates will be asked to collect 5-10 ml of breastmilk with the use of an electrical pump between 01:00-05:00 at three specific time points: 3^{rd}-5^{th} day (colostrum), 10^{th}-14^{th} day (transitional milk) and 20^{th}-28^{th} day (mature milk). Blood samples from the preterm neonate will be collected as follows: a. for premature neonates > 33 weeks, 2 samples will be collected (4^{th}-7^{th} day of life and 10^{th}-14^{th} day, which will coincide with a gestational age of 35-36 weeks); b.for premature neonates <33 weeks, 3 samples will be collected (4^{th}-7^{th} day of life, 10^{th}-14^{th} day and at a date that will coincide with a gestational age of 35-36 weeks). Neonates' and infants' and maternal ECG will be obtained at 2 successive time intervals (neonatal period and 9 months after the birth). At 9 months, the social and cognitive development of infants will be assessed at hospital by the administration of the *Bayley Scales of Infant and Toddler Development, 3rd Edition* (Bayley, 2006)

Data analysis plan: By applying robust linear regression modeling techniques on continuous outcomes and generalized linear modeling techniques for binary outcomes, adjusting for potential confounding factors, we aim to identify the psychosocial and physiological risk factors associated to adverse preterm infants' development at 9 months, between low and high socio-economic status (SES) families. We will also use pathway approaches (Structural Equation Modeling – SEM) to study the pathways connecting exposures under study to psychosocial phenotypes.

Implications: The implications of this study may highlight the need to advance the debate about the responsibility of society to counteract health inequalities (M'hamdi, 2017) and to interrupt the pattern of intergenerational mental illness and suffering (Prom, 2022).

P3-J-645 - Breastfeeding in context: Effects of gahvora cradling in Tajikistan

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Details

Breastfeeding—a central part of the Sustainable Development Goals established by the World Health Organization—is foundational to children's health and wellbeing. Breastmilk provides nutrients necessary for growth, lowers the risk of obesity and infections, and supports brain and nervous system development. Breastfed babies show advances in motor and cognitive scores on standard assessments relative to babies not breastfed. Breastfeeding facilitates infant attachment and strengthens the maternal bond through mutual touch and maternal gaze. Breastfeeding is also more convenient and cost-effective than formula, especially in low-income economies. Rates of breastfeeding vary among countries and regions due to myriad factors, including differences in cultural norms and routines. According to epidemiological studies, only 32-39% of mothers in Tajikistan report breastfeeding their babies as compared to 83% of mothers in the U.S., according to the CDC. These low numbers may be due to underreporting, or mothers' lack of awareness of the importance of breastfeeding.

We observed breastfeeding in Tajikistan where caregivers bind infants in gahvora cradles from birth until 2 years of life. Infants lie supine with limbs and body tightly wrapped and bound to the gahvora, often for extended periods throughout the day and night. Infants remain wrapped for feeding while mothers lean over the cradle to breastfeed (Figure 1). Save the Children (2011) critiqued gahvora cradling, claiming it impedes breastfeeding. We asked whether the practice affects the quality of breastfeeding as compared to when mothers breastfeed while holding babies in arms.

Tajik infants (*N*=64, 34 females, 30 males, 0-12 months old) and mothers were visited at home. As part of a larger study, mothers were interviewed about infants' breastfeeding practices using time-diaries. Information about infants' body dimensions (weight, height, head circumference, BMI) were collected. Breastfeeding episodes in the gahvora and in mothers' arms were captured on video spontaneously, in between other tasks. Infants were observed breastfed while in the gahvora (*N*=41), breastfed outside the gahvora in mothers' arms (*N* = 9), and some in both contexts (*N*=14) yielding a total of 180 breastfeeding episodes.

From video, we scored frequencies and durations of breastfeeding episodes in the gahvora and while in mothers' arms. We also considered mutual gaze and touch in each breastfeeding episode. From time-diaries, we counted how often infants were breastfed and in what context. Breastfeeding occurred significantly more often in the gahvora than in mothers' arms, but duration of breastfeeding was similar (*M*s=4.41, 3.42 minutes in gahvora and arms, respectively). Mutual gaze occurred in nearly all breastfeeding episodes. Coding for mutual touch is ongoing. Preliminary analyses suggest that

mothers—regardless of the breastfeeding context—often touch infants on their heads, caressing or smoothing garments. Infants also touched mothers while breastfed: When their arms were not bound, infants touched mothers in both contexts.

Our study will be one of the few to report observational measures of breastfeeding and offer a cultural account on factors that may shape this universal practice. It will also inform the Sustainable Development Goals by contributing to the knowledge that may shape the quality of breastfeeding.

P3-J-646 - Parents perspectives on integrating social care and healthcare delivery for infants

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Details

Objective

Screening for health-related social needs and referring persons with unmet needs to community-based social care organizations is an integrated care approach pursued by healthcare delivery to help achieve health equity. Guided by integrated care demonstration programs and Medicaid policy, healthcare-based screening and referral programs have rapidly emerged. Advanced integrated care programs close the loop to communicate referral status, share patient-level information, and coordinate care. Screening, referral, and closed-loop features are packaged into Social Health Access and Referral Platforms (SHARPs) that are proliferating to support the implementation of integrated programs in healthcare systems. Limited evidence from social-healthcare integration programs in pediatric studies shows mixed results. Missing from this research is an understanding of the parents' perception of the program. This study explores perception of healthcare-based referrals and closed-loop features of the integrated care program among parents enrolled in evidence-based early childhood home visitation models (HVMs).

Methods

Four HVMs serving populations in geographically diverse areas of the United States recruited clients to participate in virtual interviews with trained staff (N=2) from Geisinger Health System (Pennsylvania). Individual semi-structured interviews, informed by the Consolidated Framework for Implementation Research, were conducted to explore perceptions about HVM referrals, data sharing between HVMs and clinics, and care coordination. Participant renumeration was provided. Audiotape transcripts, independent review, coding by two investigators, and study team notes allowed for data and investigator triangulation. Data collection ceased at the point of data saturation. Transcripts were analyzed using inductive thematic analysis.

Results

Participants (N=34) had at least one child and were 97% female, 9% Black/African American and 6% Hispanic. 65% had a High School/GED or less education. Participants were enrolled in HVMs including Nurse Family Partnership (74%), Parents as Teachers (12%), Family Check Up (9%), and Healthy Families America (5%). Three primary themes emerged from the data: 1) Clinic-based referrals are but one pathway to HVM; 2) Active referrals that directly connect individuals with the HVM or clinic are appreciated to minimize navigation burden; and 3) Closed-loop features, with privacy protections, are welcome to reduce fragmentation and enhance health literacy. Participants rarely mentioned social needs screening even when referred to HVM by clinicians, hospital, or health insurance. Opt-out, active referrals are acceptable but written permission for closed-loop features is largely expected with details about data types and time limits.

Conclusion

Social and health care integration approaches should acknowledge multiple entry points into social care services and avoid over-medicalizing the referral pathway from the clinic to social care; the opposite pathway may be indicated. Health-related social needs screening is often the first critical feature in social-healthcare integration, but innovation is warranted to identify eligible families. Strategies that make it easier for families to connect with community-based organizations and clinics are valued. Flexible stages of entry into the program may be warranted to allow for closed-loop features like data sharing and care coordination in the absence of screening and referral. With appropriate protections, parents endorse bidirectional social and healthcare integrated delivery programs to better support equitable physical health and infant development.

P3-J-647 - Association between maternal childhood trauma and levels of immunoactive factors in her breast milk and infant growth

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Details

Introduction:

A mother's experience of childhood trauma can affect changes in the immune system in adulthood. These changes may be reflected in the levels of immunoactive factors in breast milk. The aim of our study was to assess the association between maternal trauma and the levels of secretory IgA (SIgA), IgM, IgG and lactoferrin (LF) in breast milk. We hypothesised that maternal childhood trauma (MCT) affects the function of the mother's immune system and on the levels of immunoactive factors passed

on to the offspring. Changes in the levels of immunoactive factors reflect in the alterations in the child's physical development.

Methods:

The study group included 108 breastfeeding mothers and their healthy five-month-old infants. Maternal childhood trauma was determined by the Early Life Stress Questionnaire (ELSQ). The weight, length, and head circumference of the infant were taken at birth, 5 and 12 months postpartum. Breast milk samples were collected to test for SIgA, IgM, IgG and LF using the ELISA method. Differences in levels of immunoactive factors and infant growth parameters were examined between mothers with high (HCT) and low childhood trauma (LCT).

Results:

The results indicate a statistically significant increase in SIgA ($F=5.67_{2.106}$; $p<0.05$) and IgM ($F=4.04_{2.106}$; $p<0.05$) in HCT mothers at 5 months pospartum. No relation was found between immunoactive factors and maternal childhood trauma at 12 months postpartum. We found an association between MCT and infant size at 5 and 12 months. The children of mothers with HTC had higher weight ($F=8.06_{1.94}$; $p<0.01$) and greater head circumference ($F=6.17_{1.94}$; $p<0.05$) at 5 moths than the infants of mothers with LCT. Similar effects were observed for both also at 12 months ($F=7.17_{1.89,}$ $p<0.01$; $F=5.06_{1.89}$, $p<0.05$, for weight and head circumference, respectively).

Conclusion:

Our results suggest that maternal trauma may affect the levels of immunoactive factors, particularly the elevation of SIgA and IgM levels. These results also suggest that the effects of maternal childhood trauma may contribute to the developmental programming of the child both during pregnancy and after birth.

P3-H-648 - Parental practices in early childhood in Northeast Brazil

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Details

Background and Objective: The first five years of life are crucial for the child development considering brain formation and basic skills acquisition (Halpern, 2015; Miguel et al., 2019). Adverse early childhood experiences may have negative repercussions that last into teenage- and adulthood (Miguel et al., 2019). Family plays a determining role in this process by being the child's first environment (Bronfenbrenner et al., 2006). The aim of the present study was to describe parental practices of families with children born during the COVID-19 pandemic in a city in the Northeast region of Brazil.

Method: Data from a cohort of children born in July-August of 2020 (COVID-19 lockdown) was used to describe parental practices 12, 18, and 24 months after childbirth. We used the Parenting and Family Adjustment Scales (PAFAS) 20 item Brazilian version (Santana, 2018) to estimate means and Standard Deviation (SD) of PAFAS domains (Inconsistency, Coercion, Encouragement, Relationship, Parental and Family adjustments). One-way ANOVA tests were used to assess scores variations among the study's follow-up waves.
Results: A total of 306 mother-child dyads were included in the analyses. The results indicate positive parenting practices for the three time points observing a slight worsening as the children get older. For the inconsistency and coercion domains, the lower the scores indicate the better parenting practices. Scores suggest more inconsistent and coercive parental practices as the older the children got. (Table 1) However no statistical differences were observed. For the encouragement, relationship, parental adjustment, and family adjustment domains; higher scores indicate better performance. The relationship scores, that include enjoying spending time and having conversations with the child, were worse the older the children got (p=0.009). As for the encouragement, parental and family adjustments domains, no statistical differences were observed through the cohort waves. (Table 1)
Conclusion: Although parenting practices scores seem to be worsening as children grow older, positive results were shown from 12 to 24 months during the COVID-19 pandemic, among the evaluated families. Considering that negative parental practices such as corporal punishment and aggressiveness are associated with development and behavior impairment (Avezum et al., 2023), educational interventions that assist parents on how to keep the positive attitudes would be of help.

P3-J-649 - Coverage and determinants of childhood vaccination during the COVID-19 pandemic in Fortaleza, Northeastern Brazil

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Details

Previously considered a case of success in vaccine coverage, Brazil has been experiencing a decrease in vaccination coverage since 2016, aligned with the global challenge of declining coverage rates. This study aimed to show the immunization status of children born during the COVID-19 pandemic in Fortaleza, Northeastern Brazil. A cohort of 325 children was followed up at 12 and 18 months of age. The longitudinal analysis included only 313 children with both information on two survey rounds and vaccination card disponible. Their cards were checked for dose application considering the schedule of immunization recommended by the Ministry of Health. Factors associated with no retention of vaccination cards and incomplete immunization by 18 months were identified through a Tobit regression. We found that 73% of the mothers presented their child's vaccination card at both follow-up rounds. Non-availability of vaccination cards was associated with maternal age younger than 25 years and mother with a paid job. Only 33% and 45% of the children had all vaccines up to date, at 12 months and 18 months, respectively. For 3-dose vaccines, the delay rate was around 10% for the 1st dose application, but 40% for the 3rd dose. Despite delays, by 18 months of age, most children with available

vaccine cards had completed the vaccination schedule: above 95% were fully immunized with BCG, Hepatitis B, Rotavirus, Pneumococcal, Polio VIP and Pentavalent. But less than 80% were immunized with Triple Viral, Polio VOP, Hepatitis A and Yellow Fever. Adjusted factors associated with incomplete vaccination were living in a household with more than one child (p=0.010), and monthly income of less than 1 minimum wage (p=0.006). In conclusion, delays on child vaccine application were high during COVID-19 pandemic, but there was a considerable catch-up by 18 months of age. Poorer families with more than one child were particularly at risk of not fully immunized children and should be the target of public policies.

P3-J-650 - Swaddling Ear to Ear – Conceptualizing and supporting early intervention enrollment

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Details

In the US during 2020, 6,321 infants were identified as D/deaf or hard of hearing (DHH) via Early Hearing Detection and Intervention (EHDI) programs (CDC, 2023a). However, over 1/3 of those children are lost to intervention (LTI), with the most common known reason being family refusal (CDC, 2023a; b). Early Intervention Services (EI) are considered best practice and state-run services are made accessible through federal legislation (Individuals with Disabilities Education Act of 2004). LTI is concerning. It places children at a developmental disadvantage due to a lack of linguistic access and neglects the intervention in EHDI (Joint Committee on Infant Hearing, 2013; 2019).

There is a critical need to modify family responses around EI. The first step is to understand why families decline these services. The federal reporting of this refusal does not help us understand why it happens, and what can be done to support EI. Along the same lines, much of the existing and emerging literature looks at barriers in the EI system for families such as the accessibility of information on EI (Woodruff & Cienkowski, 2021), variability in EI eligibility (Woodruff-Gautherin & Cienkowski, in revisions), and the plethora of other reasons families report not seeking services (medical needs, etc.; CDC, 2023a). It is critical to now take these known barriers and understand how families factor them incorporate them into final decisions and what can be changed in that process.

Using Delphi methodology, participants were invited to give feedback and edit a model built on literature around LTI, EI service accessibility, and service provision for children birth to three years. From a pool of 155 experts in LTI who represented professionals (care providers), researchers/academics, and family members/self-advocates, 48 responses across all stakeholder groups were collected over two rounds of iterative qualitative and quantitative feedback (n=23 and n=25, respectively). The final model, approved by 86.3% of the experts, has five factors families consider when deciding to enroll in EI for a child who is DHH, families must consider their family culture, family experiences, perceived vulnerability to negative sequelae of LTI, the perceived benefits of EI, and the perceived barriers to accessing EI. Any of these elements can become barriers or facilitators of EI. A follow up study (n=34) found no statistical difference (p>.05) in expert panel perceptions of each factors relative impact on decision making (Woodruff-Gautherin, LaSpada, & Cienkowski, in preparation). This lack of a singular driving factor highlights the need for family-centered and culturally sensitive interventions.

As a public health service, LTI in EHDI is a prime example of an opportunity to combine the outlined work above with implementation science to improve outcomes (Woodruff & Lutz, 2020; Woodruff-Gautherin & Cienkowski, 2022a). A program, Swaddling Ear to Ear, was built in English based on these results (Woodruff-Gautherin & Cienkowski, 2022b) with Spanish materials in development. Pilot results of this work to be discussed will include objective measures of knowledge around EDHI, and EI, along with parental attitude measures, and qualitative interviews on the acceptability and feasibility of the program.

P3-J-652 - Multilevel modeling of infant growth trajectories across the first years of life in infants with different prenatal substance exposures

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Details

Introduction: Substance use during pregnancy has increased dramatically in the past decade and may pose significant health challenges for the rapidly growing number of exposed infants born to mothers using illicit and/or prescribed substances. Prenatal substance exposure (PSE) occurs during a time of extraordinary brain growth and organization, making it a critical period of vulnerability to environmental insult. One marker of infant development across developmental domains is growth (e.g., weight). If infants are not adequately growing, they are unlikely to be thriving in social, cognitive, motor, or language domains. Most research on infant growth has been limited to birth outcomes; however, some research has looked at growth through the first two years. The current study extends research on PSE and infant growth by systematically examining exposure to various substances and applying multi-level modeling (MLM) to evaluate the impact of PSE on infant weight across the first three years of life.

Methods: A retrospective chart review (2017-2020) of infants with PSE (n=240) and infants without PSE (n = 209) was conducted. Over five thousand weights from the first four years were extracted. MLM was used to estimate how infant weight changed over time and whether PSE predicted different trajectories over time.

Weight data were fit according to the following model taxonomy: Model A was the unconditional means model and Model B was the unconditional growth model. Models C-H sequentially added level 2 predictor variables one at a time as additional predictors to the unconditional growth model. Model I removed non-significant fixed and random effects. The composite model for the final model was:

$weight_{ij} = gamma_{00} + gamma_{01}(opioid) + gamma_{02}(THC) + gamma_{03}(methamphetamine) + gamma_{04}(benzodiazepine) + gamma_{05}(premature) + gamma_{10}(age) + gamma_{11}(age*opioid) + zeta_{0i} + zeta_{1i} + epsilon_{ij}$

Results/Discussion: Descriptive statistics for the socio-demographics characteristics of the study sample were examined. Table 1 presents the model results for the model taxonomy. For the final model, Model J, weights at time 0 (birth) for infants without substance exposure were estimated to be 4.23 kgs, on average. Infants with opioid, THC, or benzodiazepine substance exposure had lower estimated birth

weights. Infants born premature also had lower estimated birth weights. As expected, infant weights significantly increased with age. However, this increase was predicted to be significantly less for infants with prenatal opioid exposure. Figure 1 illustrates predicted mean infant weights across the first three years of life for infants with and without prenatal substance(s) exposure.

Conclusion: This study provides evidence that infants with PSE (opioids, THC, methamphetamine, benzodiazepines) have lower birthweights than infants without PSE. Moreover, prenatal opioid exposure was associated with slower weight gain over time. No other substances were significantly related to the rate of growth over time. This suggests that infants with opioid exposure should be monitored closely over the first years of life for feeding concerns, nutritional deficits, and even delays in other developmental domains.

P3-J-653 - Mother's stress and depression during child infancy predicts parental self-efficacy and media coping habits two years later

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Details

Parental self-efficacy (PSE), which comprises a parents' confidence about their ability to successfully raise children, has been associated with parent satisfaction, competence, child adjustment and psychological wellbeing (Jones and Prinz 2005; Wittkowski et al., 2017). While researchers have reported infants' difficult temperament and parenting stress are negatively related to PSE (Fang et al., 2021), researchers have yet to longitudinally investigate the nuanced effects of different kinds of parenting stress or the moderating factor of maternal depression on PSE. In addition, how parenting stress and maternal depression relate to ubiquitous, yet largely understudied parental media habits (using health apps, utilizing screentime to emotionally cope) are unknown. Such media habits have implications for continued maternal mental health and a positive parent-infant relationship.

Thus, the present study first longitudinally assessed three kinds of parent stress (parent distress, parent-child dysfunctional interaction, difficult child; Aubin, 1990) among mothers of infants and tested how each related to PSE and media use two years later (controlling for initial levels). We surveyed mothers of infants in the western U.S. and completed in-home visits for three consecutive years (n = 439, 62% White, mother age range = 17 – 43 years, median age = 30; Avg infant age = 3.5 months, SD = 3.6 months at T1). Secondly, interaction models tested whether maternal depression moderated relations between parenting stress and both PSE and media use.

For PSE, multiple regressions run in MPLUS v. 8 (Muthen & Muthen, 2024) showed significant negative main effects of parenting distress ($\beta = -.16,\ p < .01$), and maternal depression ($\beta = -.23,\ p < .001$) (all estimates in table 1). Maternal depression positively predicted the use of health apps ($\beta = -.08,\ p = .02$). For media emotion coping, we found significant positive main effects of parent distress ($\beta = .19,\ p = .03$) and maternal depression ($\beta = .40,\ p < .001$). However, an interaction effect ($\beta = -.50,\ p = .02$), showed the relation between having a difficult

child and using screentime for emotional coping became stronger and more negative as maternal depression increased, implying that infants with difficult temperaments reduce the amount of time mothers spend using their phones as coping mechanisms two years later when they also experience depression (figure 1). This last finding is likely due to the demandingness of the child combined with limited mental resources.

Interestingly, maternal depression and cognitions about being a parent (parental distress) were positively related to media use while other kinds of stress were not, implying that mothers are looking to media as an escape or remedy from mental discomfort but not necessarily from parent-child interactions. This relation was more complex for mothers of difficult children, as described. Parental distress and depression were independently the most salient predictors of PSE, emphasizing that family members, educators, and practitioners should combat feelings of parental inadequacy and maternal depression in mothers of young infants to promote PSE and appropriate use of media outlets as infants develop.