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Symposia Abstracts

Symposia 1 – Stages of predictive processing in infants and toddlers: Forming expectations, experiencing prediction error and what it means for learning and memory

S1.1 Why does puppy have a tummy ache?: Facilitating expectation using pedagogical questions to promote learning in preschoolers

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Prompting children to make predictions about causal relations can serve as an important tool for early learning (Legare, 2012). Specifically, pedagogical questions, questions asked about relevant information with the intent to teach, elicit explanations (Walker & Nyhout, in press), which in turn encourage children to generalize their understanding using both observational evidence and their prior beliefs to novel situations (Walker et al., 2016). Relatedly, prompting for explanations may also reduce prediction bias (Hirt et al., 2004), especially in domains in which children have relatively entrenched beliefs. Indeed, children who are prompted to make predictions about causal phenomena generate simpler hypotheses (Walker et al., 2017) with greater explanatory virtue (Lombrozo, 2016). We tested the effect of pedagogical questioning, compared to direct instruction (providing relevant information in the form of statements with the intent to teach), which, does not prompt prediction, but crucially, explicitly teaches children about relevant concepts. Specifically, 72 preschoolers (Mage=49 mo; 50% female), from a variety of socioeconomic backgrounds, participated in a two-week storybook intervention aimed at improving their understanding of the relations between psychological causes and bodily effects, or psychosomatic understanding. This domain was selected because it is an area in which children's beliefs are relatively entrenched, and has broader implications for health and well-being. Children were included in the study if they initially endorsed a plausible within-domain (physical) cause rather than the statistically likely, but cross domain (psychological) cause in a pretest book. Children were then randomly assigned to one of three conditions: Pedagogical Questions (PQ), Direct Instruction (DI), and Control (CT). During storybook reading, children in the PQ condition heard questions about the underlying mechanisms of psychosomatic phenomena, children in the DI condition were taught about the mechanisms, and the children in the CT condition read similar books for the same amount of time but received no information or questions about psychosomatic events. At posttest, on a measure of near transfer (a modified storybook similar to the pretest screening book), children's responses significantly differed across conditions, $F(2,69)=4.09$, $p=.021$, such that children in the PQ condition were more likely to identify the psychological cause (38%) than children in the DI (13%), who in turn, were more likely to recognize a psychological cause than children in the CT (8%) condition, $p=.017$. On a measure of far transfer (an open-ended storybook that prompted an explanation about a novel situation), children's significantly differed across conditions, $F(2,69)=5.07$, $p=.009$, such that children in the PQ condition were more likely to identify the psychological cause (33%) than children in the DI (25%), who in turn, were more likely to recognize a psychological cause than children in the CT (0%) condition, $p=.003$. Lastly, children's memory for storybook details significantly differed across conditions, $F(2,69)=3.21$, $p=.047$, such that children in the PQ condition remembered significantly more details ($M=7.33$) about the storybooks than children in the DI ($M=5.67$) and CT ($M=6.17$) conditions, $p=.018$. Results will be discussed in terms of the role of pedagogical questions in facilitating prediction, and the implications for learning, transfer, and memory.

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S1.2 Prediction and prediction error in 14-month-old infants

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Research with adults has shown that predictions can be correct or incorrect, and each has the potential to support cognitive changes. When your prediction is correct, it allows you to use what you have learned to support more efficient processing of your sensory input (Kersten & Yuille, 2003; Kutas, DeLong & Smith, 2011; Wei & Stocker, 2015). When your prediction is incorrect, this can generate prediction error signals in the brain (Hollerman & Schultz, 1998; Rao & Ballard, 1999; Friston, 2005), which helps you update your predictions and promotes learning. Recent work in developmental psychology, using different methods such as EEG (Kouider et al., 2015) and fNIRS (Emberson et al., 2015), have shown that infants also experience top-down sensory prediction in the brain suggesting markers of prediction are also present in infants. But whether or not infants use prediction and prediction error in a more sophisticated, adult-like way has yet to be answered. To study the relationship between prediction and prediction error early in development, we used anticipatory eye movements (AEM) to index prediction and pupil change, to index prediction error. Infant learning has never been addressed using this unique combination of behavioral measures. In our learning task, 14-months-old infants are presented with a target on either the left or right side of the screen for 8 trials (pre-switch). Then, the same target appeared in the other position for 8 (post-switch) trials. This pattern was repeated with new targets and locations for 3 blocks. In pre-switch trials, we hypothesized that infants would predict the target location and generate AEMs to that location. Post-switch trials will allow us to examine how predictions (AEMs) relate to prediction error (pupil) and then subsequent predictions. Our results show that infants who learn better (i.e. have higher percentage of correct AEMs in pre-switch) make more mistakes in the form of incorrect AEMs when the target switches ($r = 0.35$, $p = 0.06$). Infants who learn better also have larger pupil change during the first trial of post-switch, which was designed to elicit the strongest prediction error, compared to infants who did not perform as well in the task ($r = 0.37$, $p = 0.05$). We will also model the trial-by-trial dynamics of prediction and prediction error in relation to canonical computational learning models that include prediction and attention (e.g., Rescorla-Wagner and Pearce-Hall models). Taken together, these results suggest that more prediction is correlated with larger prediction error, as evidenced through infants' eye movements and pupil size and, like adults, prediction and prediction error are intertwined.

S1.3 Preschoolers remembering and learning from predictable and unpredictable events

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Young children are adept at tracking the predictable regularities in their environment (Aslin, 2014; Gomez & Gerken, 2000; Saffran, Aslin, & Newport, 1996). Further, recent research suggests that the predictability of events may influence how young children learn from those events (Benitez & Smith, 2012; Benitez & Saffran, 2018; Stahl & Feigenson, 2015; 2017). In particular, events that are predictable facilitate toddlers' word learning in comparison to events that violate predictions (Benitez & Saffran, 2018). In three experiments ($N=179$), we examine if predictability also affects memory and learning in preschool-aged children. We presented 3- to 5-year-old children with a tablet task that displayed 3 locations on the screen. When 1 of the 3 locations turned green, children had to touch that location to reveal a hidden animal. The order of locations to touch followed a predictable spatiotemporal pattern

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(1, 2, 3), such that, over trials, children could learn to predict which location would light up next to reveal an item. Critically, we presented novel items (Exp. 1), novel sound-item associations (Exp. 2), or novel word-item associations (Exp. 3) during the sequence, half from events consistent with the spatiotemporal pattern (Predictable: 1, 2, 3), and the other half from events that violated the spatiotemporal pattern (Unpredictable: 1, 2, 1). In all experiments, children showed slower reaction times to Unpredictable events than to Predictable events [$F(1,13.76)=247.26$, $p<0.001$], demonstrating learning of the predictable sequence. The key question was whether children remembered or learned differently from Predictable or Unpredictable events. In Experiment 1 ($N=28$, Mean Age= 4.6, $SD=0.89$), we examined if predictability affected children's memory for the novel items. Results showed that children remembered items accurately when presented during both Predictable [$M=0.71$, $SD=0.21$; $b=0.97$, $STE=0.22$, $z=4.39$, $p<0.001$] and Unpredictable events [$M=0.71$, $SD=0.25$; $b=1.06$, $STE=0.27$, $z=3.92$, $p<0.001$]. There was no effect of predictability on accuracy scores [$b=0.09$, $STE=0.28$, $z=0.33$, $p=0.74$]. In Experiment 2 ($N=31$, Mean Age= 4.6, $SD=0.83$), we examined children's learning for sound-item associations presented during Predictable or Unpredictable events. Results again showed learning and equal performance [$b=0.19$, $STE=0.28$, $z=0.68$, $p=0.50$] for sound-item associations presented during Predictable [$M=0.62$, $SD=0.33$; $b=0.57$, $STE=0.28$, $z=2.05$, $p=0.04$] and Unpredictable [$M=0.63$, $SD=0.34$; $b=0.76$, $STE=0.30$, $z=2.51$, $p=0.012$] events. Similarly, Experiment 3 ($N=120$, Mean Age= 4.47, $SD=0.86$) again showed that children learned novel word-item associations well regardless of predictability [Predictable: $M=0.59$, $SD=0.33$, $b=0.49$, $STE=0.15$, $z=3.21$, $p=0.001$; Unpredictable events: $M=0.61$, $SD=0.33$, $b=0.52$, $STE=0.14$, $z=3.65$, $p<0.001$; Predictable vs. Unpredictable: $b=0.03$, $STE=0.18$, $z=0.21$, $p=0.84$]. Across the three experiments, preschool-aged children remembered and learned equally well from predictable and unpredictable events. Unlike toddlers, children in our task were able to robustly encode novel associations even when they were presented during prediction-violating events. Given our large dataset, we are currently conducting exploratory analyses to examine individual differences in whether children benefit from predictability. The results together should shed light on the role of predictability for young children's remembering and learning.

Symposia 2 – Naïve epistemology: Children's intuitive theories of knowledge and informativeness

S2.1 Investigating children's developing understanding of integrity in others' epistemic practices

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We live in a society increasingly inundated with information, with eroding and often insufficient checks on what is authoritatively true, facing a crisis of honesty and integrity both in science and in the public sphere. Thus a pressing issue facing society is ensuring that as children develop the mental habits that will guide how they engage with the world, they learn to approach information with an evaluative lens. Fundamentally, this means understanding and fostering young children's ability to assess whether others' claims about the world are made in an intellectually honest and valid manner. This is especially true against a backdrop of a crisis of honesty and integrity in science and beyond. This talk presents a framework for investigating children's developing ability to reason about whether others are engaging in epistemic practices with integrity. Specifically, we propose three broad principles underlying integrity in epistemic practice: (1) Don't See Something? Don't Say Something. This is the principle that we ought to only make claims to knowledge that we actually have, and the corollary that if do not have the relevant

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knowledge to make a claim, we ought not to make it. (2) Be Honest About What You Know. This is the principle that, we ought to be judicious in tailoring our claims to the evidence we have, and not claim to know something we are not sure of. (3) Use Evidence to Help, not to Deceive. This is the principle that when communicating evidence, we ought to do it in a way that conveys what we believe to be true, and to do so for prosocial reasons, rather than to manipulate another's belief for our own gain. We will then present several studies investigating these principles. In one series, we find that 3- to 7-year-olds (N=120) evaluate unverified claims as less acceptable than verified ones based on sufficient knowledge. In second series of nearly-completed studies, we are finding that children understand that one's sampling behavior ought to be tailored to ones empirical question. We will present a third series of studies, currently ongoing, exploring whether children can recognize when individuals are using evidence for prosocial or deceptive purposes. Finally, we will present a roadmap and some preliminary data supporting further investigations of children's understanding of each of these principles underlying honest and transparent epistemic practice.

S2.2 Ignorance = doing what is reasonable: Children expect ignorant agents to act based on prior knowledge

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We frequently encounter novel situations, but even when we lack knowledge, we're rarely at a loss. We can often draw on our prior experiences to guide our actions, and we expect others to do the same, assuming that those who lack knowledge will apply relevant prior experiences to novel situations. It is unclear, however, whether children share these expectations. In some contexts, children judge that ignorance will lead to failure (Ruffman, 1996; Saxe, 2005); in others, success (Friedman & Petrashek, 2009; German & Leslie, 2001). In the current work, we test whether four- to six-year-olds expect ignorant agents to act according to their prior experience. In Experiment 1, children (Age: 4.05-6.99 N = 72) and two puppets were introduced to a novel toy, and learned which of three buttons activated it (see Figure 1a). Next, each agent was asked to activate another (outwardly identical) toy. One agent acted consistently with his prior knowledge, pressing the same button that activated the original toy. The other acted inconsistently, pressing a different button. Both agents succeeded. Last, children were asked to judge which agent had already known how to make all the toys go. Experience with the initial toy perfectly explains the consistent agent's choice: he simply transferred his experience with the initial toy to the novel one. But this experience does not explain the inconsistent agent's choice, and thus children may assume this agent acted based on some additional knowledge. In fact, five- and six-year-olds (but not four-year-olds) judged that the inconsistent agent was the one who already knew how to make all the toys go (see Figure 1b). This suggests that by five years, children expect both knowledgeable and ignorant agents to act according to their prior knowledge. In Experiment 2, children (Age: 3.99-6.92 N = 72) and puppets learned how the same initial toy worked. Next, each agent was asked to activate another (outwardly identical) toy. Again, one pressed the same button he had seen make the original toy go, and one pressed a different button. But this time, both failed to activate the toy. Children were asked to judge which agent knew more (but crucially, not all) about the novel toy. As before, experience with the initial toy does not explain the inconsistent agent's choice. So children may again judge that this agent acted according to some (incomplete) additional knowledge. In fact, six-year-olds (but not younger children) judged that the inconsistent agent knew more about the toy (see Figure 1b). This suggests that by age six, children not only expect ignorant agents to act according to their prior

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knowledge, but also understand that knowledge is not binary: that agents can know more or less about any given topic. In two experiments, we demonstrate that by age five, children expect ignorant agents to act based on prior knowledge, attributing additional knowledge to agents whose actions are inconsistent with their prior experience. And by age six, children understand that knowledge is continuous, attributing greater knowledge even to agents whose failed actions are inconsistent with their observable prior experience. These results suggest that young children expect ignorant agents to act based on relevant prior experience, and that children use this expectation to infer what others know from what they do.

S2.3 Children can use statistical information to infer the informativeness of others' praise

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Learning about the self means more than observing our own actions and outcomes; we also seek others' evaluative feedback about the self (e.g., praise, criticism) and learn from what others think about our actions and outcomes. Importantly, even the same feedback ("That's a great drawing!") can be perceived differently depending on the evaluator; praise from someone who usually praises indiscriminately is less informative than praise from someone who selectively praises high-quality work. The ability to understand who provides more informative feedback is a critical skill for young children as they begin to construct early self-concepts. Prior work suggests that young children are sensitive to the informativeness of others' testimony about object labels (e.g., Koenig & Harris, 2005; Sobel & Kushnir, 2013) or demonstrations of causal functions (e.g., Gweon & Asaba, 2017; Gweon, Pelton, Konopka, & Schulz, 2014) based on agents' history of accuracy or informativeness. Furthermore, children can use minimal covariation information to draw rich inferences about people (e.g., Gweon & Schulz, 2011; Seiver, Gopnik, & Goodman, 2013). Building on previous work, here we ask whether young children can infer the informativeness of others' praise from minimal covariation information about the correspondence between an agent's praise and the quality of the product being praised. We hypothesized that children can detect the statistical pattern in others' praise and use it to inform their own decisions about whose praise to endorse. In Study 1, children (preregistered; Age: 4.0-5.9, N=80) made two tracings and placed them into separate envelopes. Children then watched videos of two teachers providing feedback on another student's tracings (6 tracings total: 3 good, 3 bad). The Selective Teacher praised just the 3 good tracings whereas the Overpraise Teacher indiscriminately praised all 6. Then, participants received feedback on their own tracings: The Selective Teacher praised the drawing in one envelope, while the Overpraise Teacher praised the drawing in the other envelope. When children were asked to choose the best tracing, children chose the envelope with the tracing that was praised by the Selective Teacher (72.5%, $p = 0.006$, Binomial), but when asked to choose which teacher was trying to be nice, they chose the Overpraise Teacher (82.5%, $p < .001$). In Study 2 (preregistered; Age: 4.0-4.9, N=24), we asked whether children valued the Selective Teacher's praise because she praised more rarely; children may have simply used rarity as a cue for informativeness. The procedure was identical to Study 1, except that children were presented with the Selective Teacher (who praised only the 3 good tracings) and the Selective-Incongruent Teacher (who praised only the 3 bad tracings). When asked to choose the best tracing, again children selected the envelope that was praised by the Selective Teacher (75%, $p = 0.02$, Binomial), suggesting that they specifically trust a teacher who selectively praises higher quality work. Ongoing work is asking who young children approach for feedback and further, whether they differentially expend effort depending on who might later evaluate their work. These results

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suggest that praise is more than positive reinforcement for preschool-aged children: They are attuned to the underlying meaning of the praise and understand whose praise is more informative, and use it to make sense of the relative quality of their own work.

Symposia 3 – Applying cognitive principles to children’s learning in educational contexts

S3.1 Children's recognition and retrieval memory for words learned via storybook reading

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Research demonstrates that children's storybooks can be facilitative for word learning (e.g., Ninio, 1983); what remains unclear is how the structures of storybooks contribute to children's success in language comprehension and production. It could be that incorporating elements that engage children in retrieval practice benefits children's word learning more so than passive listening. Retrieval practice has been demonstrated to improve adults' learning over simple restudying (e.g., Roediger & Karpicke, 2006); however, it is unclear whether children benefit from the same type of retrieval practice. This study investigated the effect of retrieval practice, via recognition testing or cued recall, on children's language comprehension and production during and after storybook reading. Across three experiments, preschool children (N=167; Age Range=26-68 months) were repeatedly read a storybook introducing them to ten novel words and objects. Experiment 1 examined children's language comprehension. Across two conditions, children engaged in passive word mapping or retrieval practice in the form of a recognition memory task. After a delay, children's comprehension was assessed using a recognition memory task, in which they were asked to select and point to the label's referent from among an array of objects. Results revealed high performance at the post-test for recognition memory in both conditions. Experiment 2 examined children's language production. Across two conditions, children engaged in passive word mapping or recall practice in the form of a production task. After a delay, children's production was assessed using a recall memory task, in which they were asked to produce the words for target novel objects. Results revealed floor performance for recall of novel words in both conditions. Experiment 3 provided additional mapping and retrieval opportunities during storybook reading. Half of the children received mapping practice followed by recall, while half received recall practice followed by mapping. At a delayed production test, all children again displayed poor memory for novel words. Thus, retrieval practice in the form of recognition testing during storybook reading may be beneficial for children's comprehension of language, but recall practice may not benefit children's production of language.

S3.2 Harnessing the benefits of retrieval practice for children's learning through implementation of open-book and closed-book activities

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Retrieval practice is a powerful learning technique that can boost long-term retention of educational material (Karpicke, 2017). For optimal learning and retention, there needs to be a balance between initial retrieval success and retrieval practice difficulty (Bjork, 1994; Karpicke, Lehman, & Aue, 2014). Less research has been conducted with elementary students in this domain. In a series of experiments covering science material with fourth and fifth grade children, we manipulated the nature of the practice activity (open book or closed book; fill-in-the-blank, short answer, or cued recall) and the

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number of practice activities (one, two, three, or four practice phases). We assessed differences in initial performance and delayed performance on the same content after one week. Practice activity types were compared to each other and to control conditions of either simply reading the text passage or studying a series of questions with answers (akin to a completed study guide). We also measured children's judgments of learning of the materials at the end of the first session. Based on previous work with college students (Agarwal et al., 2008), we predicted that open-book practice would yield better initial performance than closed-book practice, but that this benefit would not persist after a delay. No prior study had implemented both open-book and closed-book practice; however, we expected higher performance after a delay when mixing text support compared to only practicing with open-book activities. As hypothesized, results indicated a benefit of the presence of text support (i.e., open-book practice) on initial performance, but generally lower performance in open-book conditions (i.e., more forgetting) after a delay. Regardless of the question format or order of practice, mixing of practice with both open- and closed-book activities tended to result in higher retention than practice with one or two phases of solely open-book or closed-book activities. Finally, children's judgments of learning tended to be higher whenever learning activities included open-book practice, as well as when children practiced three or four phases. Based on these results, we suggest that one way for teachers and parents to aid in children's learning may be to provide opportunities to answer questions both with the text present and without the text present to boost both initial success and harness the benefits of retrieval practice. If time is limited, it may be best spent allowing children to answer questions with the text present rather than studying questions and answers or simply rereading a text passage. Overall, results contribute to the larger body of research aimed at integrating cognitive science principles within educational practice.

S3.3 Does calling it 'Morgan's way' reduce adoption and generalization of the strategy?

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When describing how to solve a problem, it is common to give an example of how someone else solved it. For example, middle-school mathematics textbooks often use hypothetical students to present problem-solving strategies (e.g. Morgan solved the problem using distribution; Riggs, Alibali, & Kalish, 2015). Presenting strategies as being implemented by a specific individual (i.e., person-presentation) is meant to make educational materials more interesting and engaging. However, person-presentation reduced strategy generalization in a controlled, short-term setting (Riggs et al., 2015, 2017). In the current study, we tested whether person-presentation harms strategy generalization when strategies were compared and integrated into classroom instruction. Specifically, ninth graders learned through comparison and explanation of multiple strategies. Comparison and explanation both support learning by focusing attention to the underlying structure of problems and away from less relevant surface features (Gentner & Medina, 1998; McEldeen, Durkin, & Rittle-Johnson, 2011; Siegler & Chen, 2008). Therefore, comparison and explanation of multiple strategies could protect against the negative effects of person-presentation on strategy generalization. During a unit on solving linear equations, five Algebra I teachers and their 174 students used 9 worked example pairs (WEPs) in which strategies were either presented with pictures and names of hypothetical students (e.g., "Morgan's way"; person-presentation condition) or with a strategy label (e.g., "add up way"; strategy-label condition), with teachers randomly assigned to condition. After comparing and explaining the two strategies in each WEP, students answered generalization questions by rating how likely another student, teacher, or themselves would be to use each strategy in the future on a 5-point scale. Students completed a pretest and posttest at

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the beginning and end of the unit assessing their conceptual and procedural knowledge of the strategies as well as their procedural flexibility. Students' scores on the assessment improved from pretest to posttest (M 's = .34 to .53). Students in the person-presentation condition performed similarly on the posttest compared to students in the strategy-label condition, controlling for pretest scores (M = .53 vs .52). Their generalization ratings were also similar (M = 3.73 vs 3.70). Thus, in a long-term classroom context we found no negative effects of comparing and explaining strategies presented with pictures and names of hypothetical students. Learning different ways to solve problems and comparing strategies helps children become flexible problem-solvers (Rittle-Johnson & Star, 2007). Our findings suggest no negative (or positive) effects of teachers using students' names to label strategies, a method recognized by The National Council of Teacher of Mathematics (NCTM, 2000). Why previously found negative effects of person-presentation may not have extended to this context are discussed, including (a) comparison and explanation directing focus away from surface-features of the examples such as character names, and (b) affordances of person-presentation aiding implementation of the materials.

Symposia 4 – How do young children infer what the norms are?

S4.1 Punishment as a signal of wrong: How children's judgements of novel actions are swayed by the presence, or absence, of punishment

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In a world filled with ambiguity, how do we learn right from wrong? While some behaviors may seem clearly wrong, many others are ambiguous - only wrong in certain situations (e.g. talking without raising your hand first) or cultures (e.g. eating beef). Thus, the moral value of at least some actions must be culturally transmitted. How does this occur? Here we explore our hypothesis that the presence or absence of punishment is a powerful signal as to the rightness or wrongness of actions, with punished actions seen as more wrong and unpunished actions seen as less wrong. Punishment is a plausible moralizing force because children experience it from a young age (e.g. time outs) and even engage in it (e.g. tattling); they also expect familiar wrongs to be punished and express desire to live in a world in which regimes of punishment are present rather than absent (Bregant et al., 2016). These considerations motivate our hypothesis that children will also use the presence or absence of punishment to infer the moral valence of novel actions. We investigated children's intuitions about the signaling capacity of punishment across two studies. In each, we showed participants six novel actions performed by cartoon children. Actions differed by type and punishment information. To understand children's intuitions across a range of potential behavior, we included two types of actions, solo and dyadic. For solo actions, an actor performed a novel action on their own while a bystander watched. For dyadic actions, the novel action negatively affected a patient. In terms of punishment information, children were told that the novel action was always punished, never punished, or given no extra information (baseline). Children were asked to judge whether each novel action was "good, bad or neither." In order to explore the specific kind of information that punishment conveys, in Study 2 children were also asked to judge whether the novel action was harmful or gross. We found that both action type and punishment information affected children's ratings of novel actions. Solo actions were neutral at baseline and unaffected by the lack of punishment, but became strikingly bad when always punished. In contrast, dyadic actions were rated negatively at baseline; but, with effects of approximately equal magnitude, dyadic actions became less bad in the absence of punishment and

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more bad in the presence of punishment. Study 2 replicated these effects and added additional ratings of harm and grossness. Beginning with harm, always punished actions were judged more harmful than baseline actions and never punished actions were judged as less harmful than baseline actions. However, perceived harmfulness did not entirely account for the relationship between punishment and judgements of wrongness, suggesting that the signaling value of punishment goes beyond a narrow signal of harm. In contrast, the presence or absence of punishment did not have a strong effect on children's evaluations of how gross novel actions were. Taken together, these studies show that punishment predicts judgements of both harm and wrongness. Strikingly, punishment can turn neutral actions bad and reduce the badness of harmful actions. This suggests that punishment could be a central channel by which children learn culturally specific wrongs, thereby representing a powerful force for the moralization of previously unfamiliar behaviors.

S4.2 Do structural (versus internalist) construals of social categories support normative judgments?

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Statistical regularities between social categories and properties (e.g., between "girls" and "liking pink") can be interpreted in many ways. Vasilyeva, Gopnik, and Lombrozo (2018) found that even preschool-aged children can construe such regularities in internalist terms (e.g., as a product of the inherent characteristics of category members, such as a preference for a particular color), or in structural terms (e.g., as a product of stable external constraints shaping the options available to category members, such as the availability of pink clothing for girls vs. boys). Here we explore whether these construals influence normative judgments, specifically about the wrongness of violating the category norm (e.g., giving something pink to a boy). We predicted that an internalist construal would license strong normative judgments: if the association between gender and color is seen as reflecting inherent properties of boys versus girls, then norm violation should generate strong disapproval. The predictions for a structural construal, however, are less clear. One possibility is that because a structural construal suggests that category-property associations would be different under different structural conditions (Vasilyeva, Gopnik, & Lombrozo, 2018), norm violations should be tolerated. Another possibility is that even a structural construal will have normative implications: Vasilyeva, Gopnik, and Lombrozo (2018) found that a structural construal licensed formal explanations ("X did Y because she is a girl"), which are closely tied to generic statements ("girls do Y"; Prasada & Dillingham, 2006; Vasilyeva, Gopnik & Lombrozo, forthcoming) that have been shown to communicate prescriptive norms (Roberts, Ho, & Gelman, 2017). In a novel study with 269 3- to 8-year old children, we induced either an internalist or structural construal of a category-property association, and we examined judgments of a norm violation across these two conditions, as well as a baseline condition. Participants learned about a school where girls picked yellow fruit, and boys picked red fruit. Under the internalist framing, schoolchildren were free to pick any fruit, inviting an inference about a preference for each color. Under the structural framing, the school assigned the girls and boys to two different fields, which later turned out to bear fruits of different colors. In the baseline condition, the outcome was attributed to accidental factors. A set of explanation-generation and evaluation measures confirmed that the target construals were successfully induced. We measured norm endorsement by asking participants to evaluate how "ok" or "not ok" (1-4 scale) it would be for someone to gift a red fruit to a girl (violating the gender norm). Both the internalist and structural conditions produced higher norm endorsement (i.e., more "not ok" judgments) than the baseline condition (Mint=2.82, Mstr=3.09, Mbase=2.37, $p \leq .009$); the difference

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between the internalist and structural conditions was not significant ($p=.098$). This confirms our prediction that an internalist construal supports normative judgments, and additionally suggests that a structural construal can do so as well. We consider mechanisms that could have produced this pattern, alongside their implications for norm construal, norm endorsement, generic language, and stereotyping.

S4.3 What if everyone did that?: Young children universalize actions to make moral judgments
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Some things are harmless when one person does them, but harmful in aggregate: Things like feeding a wild animal, leaving a faucet running, or failing to vote. Kant famously proposed these are wrong because they violate a categorical imperative; put simply, he asked, What if everybody did that? Asking this question -- which we call "universalization" -- is a way to determine what actions are morally acceptable by thinking about what everyone would agree to. Theories of moral cognition typically explain how we make judgments of right and wrong using either a rule-based or an outcome-based approach. We propose that there are some moral judgments that are better explained by universalizing an action. Our model of universalization is as follows: The moral acceptability of some actions is proportional to how bad the outcome would be in a hypothetical world in which all the people who were willing and able to do the action did the action, regardless of whether those people are actually going to do the action. We test this model with experiments in adults and young children. Adults ($N=1000$) read stories involving actions that are harmless if one person does them, but lead to a bad result if many people do. For example, one person can use a newly powerful fishing method in a small pond, but if everyone did that, the fish population would go extinct. It was emphasized that if one person did the action, no one else would know about it, so one person's action wouldn't lead to many other people doing it. This was important to ensure that subjects' judgments of the action were based on the hypothetical world where everyone did the action, not an expected utility calculation of what will happen in the actual world. Half the subjects were asked the Collective Action question: the effect if N people took the action (where N was randomly sampled between 0 and 100, the number of people who could possibly take the action). Half the subjects were asked the Moral Judgment question: whether acting in that way was morally acceptable if N other people wanted to do the action. If our model is correct, then the Collective Action question would predict Moral Judgments with a high degree of accuracy and better than a model that uses only outcomes in the actual world or rules. We modeled moral judgments using a sigmoid transform of the Collective Action judgments and found a good fit ($R^2 = 0.90$), significantly better than any lesioned version of the model or the outcome or rule-based model. Young children ($n=40$, ages 3-6 years old) were told stories with a similar structure to those told to adults. For instance, it's fun if one person splashes in the pool, but if everyone does, then there would be no water left in the pool. Half of the subjects were asked the Moral Judgment question: whether the action was OK or not OK when many kids, 8 kids, 3 kids, and 1 kid want to do the action. The other half the subjects were asked the Collective Action question: what effect would be if many, 8, 3, or 1 kid did the action. Again, we found a good fit between the Collective Action and Moral Judgment data ($R^2 = 0.85$), which out-performed an outcome-only or rule-only approach. In sum, these studies show that children and adults use universalization distinct from outcome-based or rule-based methods to make moral judgments. Our model explains the fine-grained structure of these judgments.

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Symposia 5 – How children's understanding of social relationship guides their learning about others

S5.1 Mindsets about intelligence in early childhood

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Children's beliefs about the nature of intelligence have important consequences for their motivation and performance in school. Students who believe that intelligence is malleable (a growth mindset) fare better in school than students who believe intelligence can't be changed (a fixed mindset)--e.g., they are more resilient after experiencing failure and more likely to seek out academic challenges. Despite recent evidence that young children are capable of representing intelligence as either malleable or fixed (e.g., Muradoglu & Cimpian, under review), most research on mindsets has focused on older children, adolescents, and college students (e.g., Romero et al., 2014). The current research sought to (1) develop a valid and reliable scale for measuring mindsets in young children and (2) examine how young children's mindsets relate to important cognitive variables (e.g., IQ) and academic achievement. Samples in these studies were diverse and international, being drawn from the US in Studies 1 and 3 and from South Africa in Study 2. Further, because growth mindsets are particularly beneficial for children at risk for academic underachievement (e.g., Claro et al., 2016), Study 3 involved a sample of adversity-exposed children. In Study 1, we developed a new scale to measure mindsets in young children and assessed its basic psychometric properties in a sample of 112 4- to 6-year-old children (56 girls; Mage = 5.50). To assess test-retest reliability, 23 children completed the scale again roughly one month after the initial test. Items in the scale were internally consistent (12 items, $\alpha = .88$) and scores were reliable over time ($r = .51$, $p = .01$). Further, children with growth (vs. fixed) mindsets, as measured by our new scale, were more likely to seek academic challenges (i.e., they chose a difficult puzzle that they could learn from but might also get wrong; $r = .29$, $p = .002$), which provided evidence for the validity of the scale. Study 2 replicated this pattern in a sample of 331 South African children in grades 2-5. For example, children with growth (vs. fixed) mindsets were more likely to choose challenging tasks ($r = .29$, $p < .001$). Additionally, children with growth (vs. fixed) mindsets in this sample earned higher grades in mathematics ($r = .16$, $p = .019$). Study 3 extended this work by examining how mindsets relate to important cognitive variables in 6- to 12-year-old children ($N = 249$). A subset of these children had been previously exposed to caregiver adversity (e.g., foster care; $n = 144$); the others had not ($n = 105$). In addition to our mindset scale, children completed the Wechsler Abbreviated Scale of Intelligence (an IQ measure) and measures of executive functioning (the flanker test) and academic achievement (the Wechsler Individual Achievement Test). Children exposed to adversity and children in the control group did not differ in their mindsets ($p = .66$). Importantly, regardless of adversity exposure, children with growth mindsets had higher IQs ($\beta = .24$, $p < .001$), better inhibitory control ($\beta = .19$, $p < .001$), and higher reading achievement ($\beta = .14$, $p < .05$) than children with fixed mindsets. Together, these results suggest that our new scale is a promising tool for measuring mindsets about intellectual ability in young children. Additionally, these findings identify important correlates of mindsets in diverse groups of school-age children, including IQ, executive functioning, and academic achievement.

S5.2 Preschoolers use praises as social comparative cues

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As adults, we are constantly comparing ourselves to others and incorporating the evaluative judgments into our self-concepts (e.g., Festinger, 1954). However, it is unclear whether young children can form abstract self-concepts based on behavioral evidence. For example, Ruble and her colleagues (1980) found that children do not consider social comparative information when evaluating their own competence until age seven. Here, we devise a simple paradigm to assess preschoolers' social comparison ability. Given that preschoolers understand praises as cues indicating satisfying performances (e.g., Cimpian, Arce, Markman, & Dweck, 2005), we ask if preschoolers make inferences about their competence based on the praises offered to their peers ("other-oriented" praises). Additionally, our second goal is to examine whether subtle linguistic cues in the other-oriented praises affect children's self-evaluations. Prior work has demonstrated that praising children's trait (e.g., "You are a good girl/boy!"), but not their specific behavior (e.g., "You did a good job drawing"), undermines their motivation when they encounter setbacks (Kamins & Dweck, 1999). In the present work, we investigate whether the content of the other-oriented praises affects children's self-evaluations. Forty-two 4- to 5-year-old children (55% girls) and sixteen 6- to 8-year-old children (62% girls) from a small university town were invited to play a drawing game. After the drawing game, an experimenter told the participant that another child drew the same picture that day. Next, the experimenter took out the other child's picture without displaying it to the participant. After examined it carefully, she said "Wow, s/he (gender-matched with the child) is a great drawer!" (Trait-praise condition), "Wow, s/he did a great job drawing!" (Instance-praise condition) or provided no feedback (Baseline condition). Then, she looked at the participant's drawing again and provided no feedback. Children were asked four questions that assessed their evaluations of their drawing ability (e.g., "Do you think you were good or not good at this drawing game?"). We found that both younger and older children became less confident about their drawing abilities after being exposed to other-oriented praises, $ps < .05$ (see Figure 1). This condition effect was not moderated by age significantly, suggesting a continuity in using praises as social comparison cues across development. More specifically, children in the trait-praise and instance-praise conditions evaluated their drawing ability lower than children in the baseline condition, $ps < .05$, but children's self-evaluations in the trait-praise and instance-praise conditions did not differ significantly, $p = .974$, suggesting that the two types of other-oriented praises exhibit similar negative effects on undermining children's self-evaluations. In sum, children as young as age 4 engage in social comparisons to draw inferences about their own abilities, which provides evidence challenging the claim that young children's self-concepts are concrete and insensitive to specific behavioral information. Our findings also indicate that hearing praises of peers' specific episodes or their general traits has equivalent detrimental effects on children's self-efficacy. Ongoing research is investigating ways to frame other-oriented praises (e.g., "S/he worked very hard on this drawing!") that would undermine these negative consequences.

S5.3 The relationship between beliefs about self-control and self-control behaviors in childhood

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Research has revealed important developmental and individual differences in children's self-control during early childhood (e.g., Carlson & Moses, 2003). Self-control ability measured in early childhood has also been shown to predict major outcomes later in life, including academic performance and social functioning in elementary school (Blair & Razza, 2007; Eisenberg et al., 2001), educational achievement and emotional coping skills in adolescence (e.g., Mischel, Shoda, & Rodriguez, 1989), as well as finance outcomes and health in adulthood (Moffitt et al., 2011; Ayduk et al., 2000). Research has also identified

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influences that can facilitate children's self-control. For example, strategies such as distraction, reframing and distancing (see Mischel & Ebbesen, 1970; Mischel, 2014; White & Carlson, 2016) and regular intervention activities and curricula (e.g. martial arts and mindfulness practices) (Diamond & Lee, 2011) have been shown to improve self-control in childhood. Recent research has started to investigate another type of potential influence: children's beliefs about self-control. Research has found that beliefs about free will, particularly the ability to willfully "choose to" act against or inhibit strong desires, develop during early childhood (e.g., Kushnir et al, 2015). The current studies investigate the relationship between self-control beliefs and children's emerging self-control abilities. In Study 1, 54 4- to 8-year-olds completed a questionnaire measuring their self-control beliefs. Children also completed four inhibitory control tasks. As expected, children's inhibitory control improved across this age range, $r(52) = .53$, $p < .001$. Children's beliefs also changed with age: they became increasingly optimistic about their self-control abilities, $r(52) = .61$, $p < .001$. Critically, controlling for age, children who held more optimistic self-control beliefs performed better in the self-control tasks, $r(51) = .42$, $p = .002$. In Study 2, we investigated the causal direction of the link between self-control behaviors and beliefs. One hundred and forth-nine 4-and 5-year-olds completed two self-control tasks and a free will belief questions in a randomly assigned order (behaviors first or beliefs first). Controlling for age, results replicated the significant positive correlation between self-control beliefs and behaviors, $r(144) = .73$, $p = .036$. Results also revealed a causal influence of behavior on beliefs: we found significant correlation for the children who completed the self-control tasks first, $r(72) = .333$, $p = .004$; but not for children who answered the belief questions first, $r(69) = -.05$, $p = .677$. A closer look showed that the correlation was driven by self-control failure - children who failed both self-control tasks were most likely to say they could not "choose to" against or inhibit their own strong desires. These findings reveal a relationship between beliefs about self-control and self-control behaviors in U.S. children. Immediate first-person experience with self-control can shape children's beliefs about their self-control abilities. Our follow-up research shows that this relationship may be moderated by cultural contexts: The relationship was only apparent in the U.S. sample, but not in other cultures tested so far (i.e., Singapore, China, Peru). We will discuss how cultural context may play a role in the relationship between beliefs about self-control and self-control behaviors.

S5.4 Where do I fit in: Self-other overlap and resource distribution in preschool-aged children
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Recent work in developmental psychology has made great strides in understanding the structure, mechanisms, and developmental timeline of children's sense of fairness. However, most theories to date have neglected the role of the self in children's acquisition of fairness. In the first set of studies, I present work showing that children are more likely to act prosocially when the actions they've engaged in are personally costly (that is, after incurring a cost to the self). Across two studies (Study 1 $N = 48$; Study 2 $N = 49$), preschool-aged children (3-4-year-olds) who gave away valuable objects (as opposed to non-valuable objects) were more likely to give again in the future. This work suggests that children evaluate prior actions with respect to how self-relevant they may have been - actions that were personally costly are more likely to be perceived as such, and thus motivate subsequent prosocial behavior. Thus, acting on sympathy for others is fueled by the understanding that the self must incur a cost in order to act. The next set of studies will investigate the extent to which prosocial behavior is motivated by understanding that the self is similar to others. This work will use 3 measures of social-

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relatedness: 1) an emotion similarity measure in which children will be shown silhouettes depicting the "self" and "other" asked to point to where each one experiences various emotions. Data will be coded for the degree of distance children place between themselves and another, with the expectation that lower degrees of distance show that children integrate the self with another; 2) a self-other body similarity measure in which children's gestures between self and other will be analyzed for degree of overlap; and 3) a physical proximity measure in which children will be asked to place the self and other in 2 seats at a table. The work will validate these measures and also investigate the relationships between self-other overlap and prosocial behavior. Results will be discussed in terms of underlying theories about fairness and self.

Symposia 6 – Understanding individual differences in mathematics knowledge

S6.1 The effect of individual differences in parent math anxiety on home math support

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Individual differences in children's math skills are often attributed to variations in intrinsic abilities. However, research suggests that math input that children receive in the home has important consequences for the development of these differences (Levine et al., 2010; Berkowitz et al., 2015). We explore how individual differences in parents' math anxiety- fear or worry about math- impact math input in the home, which can affect children's math development (Ashcraft, 2002). For instance, highly math anxious parents who provide a lot of homework help have children who underperform in math (Maloney, et al., 2015). Research suggests that when high math anxious parents are provided with structured math input, their kids' math performance can improve (Berkowitz et al., 2015). Yet even in structured settings individual differences in parent math anxiety may impact parent-child math interactions. By examining parent-child math interactions across two different age groups, we found that highly math anxious parents provide lower quality math support than parents with lower levels of math anxiety. In study 1, we coded videos of 29 first graders (34% non-white) and their parents (76% female) doing math word problems from the Bedtime Math app together. We used a modified version of the Reformed Teacher Observation Protocol (RTOP; Sawada, 2001) scale to rate the quality of the instruction that parents offered their children. Math instruction was rated from 0-4 for each of six items: respecting the child's prior knowledge, providing opportunities for exploration, promoting conceptual understanding, understanding of the math content, promoting critical thinking, and being patient. Families' scores on this scale were higher when parent math anxiety, measured by the Short Math Anxiety Rating Scale (sMARS; Alexander & Martray, 1989) was lower ($\beta = -.361$, $t=-2.145$, $p=.041$). Instructional quality was also higher when child math ability, measured by the Woodcock-Johnson Applied Problems, was higher ($\beta = .354$, $t=2.101$, $p=.045$). In Study 2, we coded videos of 50 7th grade children (38% non-white) and parents (90% female) doing math problems together, and problems concerning the arts. Again, high math anxious parents were less supportive than low math anxious parents. While working on the math problems, high math anxious parents generated a smaller proportion of the dyad's solution strategies than low math anxious parents (95% Highest Posterior Density Interval: -0.72 to -0.13 on a logit scale). In addition, higher math anxious parents disagreed less often with their children's ideas (95% HPDI: -0.55 to 0.02). Furthermore, high, but not low, math anxious parents expressed more confusion about the math problems than they did about the arts problems (95% HPDI: 0.05 to 1.21). These differences were not observed in the context of the arts problems. High

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math anxious parents were found to be more hands off than low math anxious parents when working on math, but not arts, problems with their children. Across two grade levels, we find that parent math anxiety impacts parent/child math interactions. While interacting with younger children, math anxious parents provide lower quality support. While interacting with older children, math anxious parents provide less support. These studies provide insight into how individual differences in parents' math attitudes relate to their math support, which sheds light on how variations in math achievement may arise

S6.2 16 is one more than 15: The role of the successor principle in building mathematics knowledge
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A key conceptual insight about counting, integers and arithmetic is the successor principle (cardinality for each count word is cardinality of previous count word plus one; Gelman & Gallistel, 1978; Sarnecka & Carey, 2008), and children understand it well after they become cardinal principle knowers (Cheung, Rubenson & Barner, 2017). However, little is known about individual differences in understanding the successor principle across a wide range of numbers or in both directions (adding vs. subtracting one), especially in children from diverse backgrounds, nor how these individual differences relate to math knowledge beyond counting. In Study 1, children in the Spring of Kindergarten (N = 65, mean age = 5.5 years, 52% non-white, 52% received financial assistance) displayed successor principle knowledge for numbers ranging from 15 to 116, using a unit task (extended from Cheung et al., 2017). At least 80% of children were successful on each item and 59% of children were successful on all 10 items. Knowledge was a bit lower for children who received financial assistance or who were from minority groups, but not significantly so. Most children (63%) could also count to 100 and these children also had significantly higher successor principle knowledge than those who could not count to 100, M = 74% vs 95% correct. Importantly, children's successor principle knowledge was strongly related to their concurrent general numeracy and broad math knowledge, $r(59)$'s = .45 and .29, respectively, even after controlling for age and general cognitive skills (i.e., verbal and visual-spatial working memory and verbal ability). In Study 2, pre-K children (N = 212; mean age = 4.71 years, 47% non-white) displayed some successor principle knowledge for numbers ranging from 3 to 34 (M = 67% correct). Performance was above chance for every number but 12, including for new items that involved subtracting an object; 9% of children were successful on all items. Knowledge was significantly lower for children from minority groups (M = 64% vs. 71% correct), with income data forthcoming. Children's successor principle knowledge was correlated with their concurrent general numeracy and broad math knowledge, controlling for age, r 's = .43 and .48, as well as with two measures of children's oral counting knowledge, r 's = .48 and .50. Finally, some children received 5 training sessions that included activities focused on the successor principle for set sizes 1-10. However, these children did not gain greater successor principle knowledge than children who did not receive training (M = 67% vs. 68% correct). Overall, individual differences in children's understanding of the successor principle persist through Kindergarten, with some children mastering the principle even for numbers above 99 by the end of Kindergarten. Children from minority groups may show some delays in this knowledge in pre-K. Importantly, these individual differences in successor principle knowledge are related to children's general numeracy and broad math knowledge. This supports the theory that successor principle knowledge is core to developing math knowledge (Sarnecka & Carey, 2008; Cheung, et al., 2017). However, our training on the successor principle was not successful, nor was a past effort (Spaepen et al., 2018), indicating the need to develop effective

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instructional methods and to test for causal relations between successor principle knowledge and broader math knowledge.

S6.3 Individual differences in attention uniquely predict math outcomes in preschoolers at high risk for math difficulties

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Individual differences in domain-general skills such as executive functions and language predict growth in math in pre-kindergarten. Approximate number system (ANS) acuity, a domain-specific skill, may also contribute to individual differences in math; however, the strength and nature of this relationship has been questioned. This study tested what domain-specific and domain-general abilities at the beginning of pre-kindergarten uniquely predict math outcomes at the end of pre-k. We used a group selected for very low math knowledge; included attention (ability to sustain attention and ignore/inhibit distracting information) given its role in the development of executive skills and for all levels of information processing; tested ANS acuity in the presence of those domain-general skills (working memory, inhibition) thought to account for the relation of ANS acuity and math; and employed autoregressive models controlling for math at the beginning of pre-k. Children were in pre-k programs for children with SES disadvantage. From this general "at risk" sample, only children entering pre-k with the lowest math knowledge (541 of 1700 screened) were consented and randomized to a math plus attention training intervention, a math only intervention, or a business-as-usual control condition (Barnes et al., 2016). The sample was 47% female, 72% Hispanic, and 18% African American. Assessments and interventions were in the child's first language (English or Spanish). Hypotheses for this talk were: 1) With the inclusion of the auto-regressor, domain-general cognitive abilities (attention, working memory, phonological awareness) will account for significant additional variance in math outcomes; 2) ANS acuity will not predict growth in mathematics in the presence of visual-spatial working memory and inhibition; 3) Attention will account for unique variance in math with other predictors in the models. Hierarchical regression analyses were conducted for the Test of Early Mathematics (TEMA-3) and the Child Math Assessment (CMA). For end of pre-k CMA, the model with time 1 CMA, condition and the cognitive predictors accounted for about 50% of the variance (30% for CMA pretest; 8% for condition; 12% for other predictors, with attention at 7% and working memory at 3%). Regardless of the order of entry, attention and visual-spatial working memory explained most of the variance in CMA scores among the cognitive measures. For end of pre-k TEMA-3, time 1 TEMA-3 scores accounted for 30% of the variance, and cognitive variables added an additional 9% (condition added less than 1%). Regardless of order of entry, attention showed the largest effects (8%) followed by visual-spatial working memory (1%) and phonological awareness (1%). ANS acuity explained minimal or no variance across measures and analyses. Findings suggest that attention and visual-spatial working memory are important for growth in mathematics in pre-k for children who start school with particularly low mathematical knowledge. Implications are as follows: 1) Given the strength of the effects for attention, attention could be an important addition to early assessment for risk; and 2) Intervention research might manipulate aspects of attention (of the instructional math environment and of the learner) as a means for improving math learning in young children at high risk for math difficulties.

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S6.4 SES and sex differences in spatial skill and mathematics

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Children of different sexes and different socioeconomic status (SES) perform differently on cognitive and academic measures (e.g., Levine, Vasilyeva, Lourenco, Newcombe & Huttenlocher, 2005; Noble, McCandliss, & Farah, 2007). Understanding these differences is important to addressing achievement gaps and improving child outcomes. Whereas main effect differences have been investigated, few studies have examined differences in relations among skills. In the present study, we tested whether the relations between spatial skill and mathematics were moderated by individual differences in SES, sex, or both, as a secondary analysis of a previously published cross-sectional dataset (Mix et al., 2016; Mix et al., 2017). The dataset included 1592 children (K, 3rd, and 6th grade) tested with 14 measures of spatial skill and mathematics from a diverse sample of communities ranging from impoverished to upper middle class. Preliminary analyses of the combined dataset, presented previously, revealed that boys outperformed girls on both spatial ($F(1, 1083) = 19.458, p < .001, \eta^2p = .018$) and mathematics tasks ($F(1, 1083) = 5.009, p = .025, \eta^2p = .005$), and children from higher SES families also outperformed children from lower SES families on both spatial ($F(5, 1083) = 21.898, p < .001, \eta^2p = .092$) and mathematics tasks ($F(5, 1083) = 23.501, p < .001, \eta^2p = .098$), and no significant interactions. Using multi-group confirmatory factor analyses (MGCFA), we also observed configural invariance across subgroups, suggesting that the latent structure underlying performance on spatial and mathematics tasks was the same across sex and SES. However, further analyses have revealed subtle differences among subgroups. Hierarchical clustering of the item correlation matrices indicated that certain spatial tasks clustered with mathematics performance tasks for some groups but not others. For example, among kindergarten girls, the ability to perceive scenes from multiple perspectives was clustered with mathematics tasks but not with other spatial tasks. Perspective-taking was also clustered with mathematics items for low-SES but not high-SES kindergarteners. Given that kindergarten girls and those from low SES families also performed worse on mathematics than groups without this same clustering, perspective-taking skill may relate to a compensatory strategy that leads to better performance within these lower performing groups. The measurement invariance models of the MGCFA also indicated that certain items functioned differently between groups. Specifically, achieving partial invariance for the kindergarten subgroups required relaxing the intercepts for visual motor integration (high SES girls) and word problems (low SES girls). Taken together, these findings suggest that kindergarten girls may use abilities other than mathematics or space to answer visual motor integration and word problems items or that these items are biased in favor of girls at this developmental stage. In sum, males and high SES students outperformed females and low SES students on both spatial and mathematical tasks. However, the magnitude of these differences varied across age groups, and there were subtle differences in the way specific spatial measures related to mathematics across sex and SES. These differences might point to instructional approaches that could help close sex and SES gaps in academic outcomes.

Symposia 7 – How parent authoritarianism and cultural upbringing shape children's learning and proto-political cognition

S7.1 Minimal but meaningful: Probing the limits of randomly assigned social identities

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People cluster into kinds and categories based on a wide range of identities, including sex/gender, race, and nationality. Some such groups are plausibly grounded in evolved differences (e.g., sex) or rich social meaning (e.g., nationality), but others seem much less meaningful because they are not clearly related to deep and important properties (e.g., teams picked randomly on the playground). It is intuitive to think that people develop stronger ingroup biases towards more meaningful groups, especially those that reflect important and stable distinctions between people. However, little developmental work has probed this intuition. Here we show that it may well be wrong. The present studies (total $n = 151$, age range 5 to 8) experimentally manipulated meaningfulness in randomly assigned novel social groups (the "Green Group" and the "Orange Group") and measured the resulting ingroup biases (including preference, similarity, and resource allocation). To experimentally manipulate the level of meaningfulness we experimentally varied the group assignment procedure. Children placed their hand on a machine that we told them would assign them to one of two groups. Half of the children were told that the machine could look deep inside them to reveal their true category membership (the maximal condition), while the other half of the children were told that the machine assigned them to a group randomly (the minimal condition). Study 1 showed that even in the arbitrary and presumptively meaningless minimal condition, 5- to 8-year-olds developed equally strong ingroup biases as did children in the more meaningful maximal condition, despite the groups being well-differentiated on manipulation check items relating to meaningfulness. While we entered this line of work with the intuition that increasing the meaning associated with the maximal condition would increase ingroup bias, the results from Study 1 instead suggest that differentiating the two conditions would require decreasing the meaning of the minimal condition. This became the goal of Study 2. Study 2 explored the lengths required to effectively reduce ingroup biases by further emphasizing the arbitrariness of the grouping dimension in the minimal condition. We did this in two ways. First, we incorporated a training procedure involving coin flips to emphasize the unpredictability of random processes such as the group assignment procedure. Second, and perhaps more importantly, after the machine assigned them to a group the experimenter switched their group assignment for an explicitly external reason, claiming they had run out of wristbands of the initially assigned color. Now bias in the minimal condition was attenuated on preference and similarity measures, though it persisted in resource allocation behavior. These results indicate that it is surprisingly easy to create powerful group affiliations, and that one has to go to great lengths to counteract the tendency to imbue newly encountered social groups with rich affiliative meaning. These findings have critical relevance to the broader project of understanding the early emergence of prejudice and discrimination, and bolster the contention that mere self-categorization into a group is sufficient to induce robust ingroup biases in children (Dunham, 2018).

S7.2 (Un)common knowledge: Children use social relationships to determine who knows what
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Knowledge is power. Possessing information allows humans to competently interact with the complex world around them. For social agents, it is not only important to possess knowledge oneself, but it is also critical to know who is "in the know" and who is not. Indeed, effectively navigating social and communicative interactions requires understanding that some people know information that others may not. For example, if Alice is deciding whether to discuss Sam's secret with Erica, it is important for Alice to know whether Erica already knows Sam's secret. Exposing another's private information can have devastating social consequences, so discussing the secret may be okay if Erica already knows it, but

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not if she doesn't. One reasonable cue that people could use to predict other people's knowledge is their social standing and their relationships with others. In our example, you may infer that if Erica and Sam are friends (rather than enemies), then Erica would be likely to know Sam's secret. Here, we investigate if and when children begin to use social relationships to predict who has access to the same knowledge ("shared knowledge"), and whether their predictions change based on the type of social relationship and/or the type of knowledge. We also compare children's reasoning about shared knowledge (e.g., a secret) to their reasoning about "common knowledge," which everyone should reasonably be expected to know (e.g., the wrongness of moral violations). In three studies, we told 4-to 9-year-olds (N=227) that a target child knew three things: that hitting was wrong (moral knowledge), a personal secret (personal knowledge), and how to celebrate a novel holiday, Festivus (conventional knowledge). Then, we asked whether other character's, such as the target's friend (Studies 1-3), schoolmate (Study 1), national groupmate (Study 2), and sibling (Study 3) knew each type of knowledge. In all three studies, children accurately used relationships to infer what other people knew. In particular, they expected moral knowledge to be shared widely (e.g., to be "common knowledge"), but expected personal to be shared selectively with friends, and conventional knowledge to be shared with groupmates and siblings. Moreover, with age children increasingly considered both the type of knowledge and an individual's social relationships when reporting who knew what. Our results provide support for a "Selective Inferences" hypothesis. That is, rather than relying merely on closeness, children recognize that the type of social relationship that connects two people is predictive of the type(s) of knowledge the two agents are likely to share. Overall, these studies suggest that children's early attention to social relationships facilitates an understanding of how knowledge transfers--an otherwise challenging cognitive process.

S7.3 Preschoolers use minimal information about social groups to infer individuals' group membership and preferences

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Categories organize a jumble of experiences into flexible, generalizable knowledge. For example, if a child learns that a "blicket" squeaks, she might expect the next blicket she encounters to also squeak. Just as categories like "blicket" support children's learning about objects, social groups support learning about people. While some classes of social groups have existed over evolutionary time (e.g., kin), others share deep, meaningful similarities in their knowledge and interests despite being a recent invention (e.g., cognitive scientists). The meaning attached to these groups thus stems, in part, from regularities among the people within it. In this work, we combined computational and behavioral methods to examine how children construct their knowledge of social groups from minimal patterns of evidence. In particular, we examined whether children can use statistical information about how preferences are distributed across groups to constrain their inferences about the preferences and group membership of new individuals. Children (N = 97, age 4?5) observed the preferences of novel agents (Gazorps) in two minimal social groups (blue team, red team). Children saw four members of each group choose their favorite of two novel fruits, bubba or kiki. Children then met a new agent (the target; Fig. 1a). In the Infer Group condition, children saw which fruit the target likes and were asked whether it is on the red or blue team. In the Infer Preference condition, children saw which group the target is in and were asked whether it likes kiki or bubba. Each child saw one of three possible distributions of fruits across the two teams, which differ in how strongly they support children's inferences about the target's group

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membership and preferences (Fig. 1b, left). We used a Bayesian beta-binomial model to formalize our hypotheses about children's beliefs about each team and their expectations of the target. Overall, we find that children use this minimal evidence to make quick, flexible inferences about the target. In the Infer Group condition, children expected the target agent to belong to the group that was more likely to share its preferences--even in subtle cases where the target's preference was not deterministically associated with a single group. In the Infer Preference condition, children expected the target to share its teammates' preferences when preferences were consistent in both groups (Consistent & Diagnostic) and were split when preferences were inconsistent in the target's group (Diagnostic). However, children were also split when preferences were consistent in the target's group, but inconsistent in the other group (Consistent). Ongoing work is currently testing the possibility that children's predictions are based not only on hypotheses about groups, but also overhypotheses across groups. These results are cause for both hope and concern. On one hand, these results suggest that children can build rich, generalizable representations of social groups from just a few observations and, critically, that these representations reflect the evidence they've observed. On the other hand, children in our task learned about fairly neutral properties of social groups that they're not a part of. In naturalistic contexts, these inferences might easily go awry, supporting the formation of biases and stereotypes. Our results are thus relevant to understanding how prejudice forms--and how it might be corrected with evidence.

S7.4 The intergroup consequences of representing friendship as same-race

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The United States' racial landscape continues to be marred by pervasive patterns of structural segregation. In other words, our societal structure--that is, the patterns of relationships between entities within society and the arrangement of groups within society--continues to reflect the separation of Black and White individuals. Why have these patterns of structural segregation persisted over legal, economic, attitudinal, and cultural shifts? I propose that one possibility is that people mentally represent important relationships, particularly friendship, as being between same-race individuals as opposed to cross-race individuals. Towards this aim, I investigate whether this mental representation develops early (Study 1), is evident in adulthood (Study 2), and has the potential to maintain patterns of structural segregation (Study 2). Study 1. White children were presented with one target and four potential friends and asked to indicate whom the target should befriend (N=96; 8 trials; Study 1a: indicate 1 friend/trial; Study 1b: indicate up to 4 friends/trial). Children were more likely to indicate that same- (vs. cross-) race peers should be friends (Study 1a: same-race-75%, cross-race-25%, $p < .001$; Study 1b: same-race-90%, cross-race-53%, $p < .001$). Study 2. Using a highly repeated measures, within subjects design, a diverse set of college students (N=125) were exposed to 40 randomized pairs of people presented side by side (20 same race & 20 cross-race pairs), and in a forced choice paradigm asked to indicate whether that pair of people was "friends" or "not friends". Participants' racial attitudes and warmth towards each individual in the pair was measured. Overall, people were more likely to indicate that same-race pairs were friends (73%) compared to cross-race pairs (66%), $t(4838)=5.329$, $p < .001$. Importantly, the extent to which people mentally represented friendship as same-race was independent of people's own racial attitudes, and perceptions of each individual pictured in the task, all $|rs| < .096$, all $ps > .295$. With the results of Study 1, these results suggest that even early in development people robustly represent friendship as same-race. Moreover, such representations are conceptually distinct from racial attitudes and warmth, suggesting an additional mechanism by which structural segregation

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may persist. Intergroup consequences of representing friendship as same-race. The more an individual represented friendship as same (vs. cross) race: the less interested they were in befriending novel individuals of a different race ($p=.015$); the less diverse their friendship network ($p=.036$); the less they reported believing that neighborhood segregation was a problem that needed to be rectified ($p=.043$); and the less diversity they included in a map of their ideal neighborhood ($p=.005$). All of these results remained significant even when controlling for people's racial attitudes. Thus, representing friendship as same-race has both interpersonal and structural consequences, shaping friendship networks and residential neighborhood design. Discussion. Whereas prior research has traditionally focused on understanding people's racial attitudes, or perceptions of others' racial attitudes, the present results provide new evidence of the importance of understanding how people reason about relationships. Representing friendship as same-race may indeed perpetuate the pervasive patterns of structural segregation found in the U.S.

Symposia 8 – Pretense, counterfactuals, and future hypotheticals: Relating different abilities to reason about possibilities in development

S8.1 Causal learning, counterfactual reasoning and pretend play: A cross-cultural comparison of Peruvian and U.S. children

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One important role for childhood pretense may be in the development of causal inference. Previously, Buchsbaum, Bridgers, Weisberg, and Gopnik (2012) demonstrated middle class U.S. children's ability to maintain a newly learned causal relationship within a pretend scenario, and also found a correlation between children's causal counterfactual reasoning abilities and their causal pretend play. These results could suggest that pretend play is related to the development of causal inference and counterfactual reasoning. However, while pretense is characteristic of human children across cultures, aspects of it have been found to vary by culture, and exactly how and what children learn via pretend play is still poorly understood. Middle class North American children engage in pretend play more often than children from other backgrounds, and some researchers suggest that extensive pretend play may not play a significant, or universal, role in learning (Lillard et al., 2013). We replicated the Buchsbaum et al. study in a population of low-income Peruvian children ($N = 62$), where pretend play may be less ubiquitous. Children learned a novel causal relationship (A causes C; B does not cause C.) Then they answered counterfactual questions about the causal relationship, and finally they engaged in pretend play and answered questions about the causal relationships in the pretend scenario. As in the North-American children, Peruvian children's ability to consider counterfactuals about the causal system was significantly correlated with their ability to reason about it during pretense, $r = 0.35$, $p = 0.005$.

Interestingly, Peruvian children were significantly better at answering questions about hypothetical causal outcomes during pretense than when asked counterfactually, $t(61) = 3.95$, $p < 0.001$. In addition, Peruvian children provided less consistent responses to both the counterfactual, $t(120) = 3.54$, $p = .001$, and pretense, $t(120) = 2.417$, $p = .017$, questions than did U.S. children. However, though the pretense and counterfactual scores differed across cultures, the relationship between the two measures was the same across cultures. Across cultures, children who provided accurate responses to the counterfactual questions also tended to provide answers during pretense that were consistent with the real world

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causal relationship. There was no difference between U.S. and Peruvian children's pretense performance when counterfactual performance was taken into account, $F(1, 118) = 1.6$, $p = .209$, as well as no interaction between culture and pretense performance $F(1, 118) = .278$, $p = .599$. Taken together, this indicates that the relationship between pretense and counterfactual reasoning is similar across cultures, even though children's average ability to answer these questions differed across cultures. Follow up work with a Low-SES US sample is ongoing, but preliminary data show a pattern similar to Peruvian low-SES children, and different from higher-SES children in the same geographic region. This is the first cross-cultural evidence for a relationship between causal counterfactual reasoning and pretense. Future research will explore more specifically how cultural variance in play may relate to the development of causal reasoning while engaged in pretense and when reasoning.

S8.2 Children's counterfactual and future hypothetical inferences about different causal structures
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Whether and when children can contemplate counterfactual possibilities (e.g., "if X hadn't happened, would Y have happened?") is the subject of significant debate. Some research suggests that children can reason counterfactually in the preschool years (Harris et al., 1996; Nyhout & Ganea, 2019), while other work shows limits to this ability (Rafetseder et al., 2013). In particular, the relation between causal and counterfactual reasoning has been debated, with some researchers arguing that counterfactuals are integral to causal inference (Lewis, 1973; Woodward, 2003) and others arguing that causal knowledge is primary (Edginton, 2011). Several accounts predict that children should be able to reason counterfactually about an event if they understand its causal structure. For instance, according to Bayesian learning models, children's judgments about counterfactual interventions should be compatible with their representation of causal structure (Gopnik & Schulz, 2007). The developmental evidence for this to date is mixed (Burns & McCormack, 2011; Frosch et al., 2012; Schulz et al., 2007). Here we asked (1) whether children who show a robust understanding of various causal structures will also be able to consider the effects of counterfactual interventions to these systems, controlling for their complexity in terms of the number of variables and causal relations; and (2) whether children would be better able to consider possibilities when framed as future hypotheticals, given debates about differences between counterfactual reasoning and future thinking (Beck et al., 2006). Children learned about 3 physical systems in 3 causal models (within-subjects): causal chain (A causes B, which causes C), common cause (A causes both B + C), and common effect (A + B both separately cause C). Stimuli were presented on a touch screen. Children interacted with each system by activating switches on the screen. They were asked causal questions, followed by counterfactual (CF) or future hypothetical (FH) questions about each system. In Study 1, 3-, 4-, and 5-year-olds ($N=72$) answered causal questions with a high degree of accuracy, binomial tests, $ps < .001$. Three-, 4-, and 5-year-olds' performance was above chance for the common effect (overdetermined) model only, $p < .034$. In Study 2, 4- and 5-year-olds ($N=38$, target $N=48$) answered CF or FH questions about the 3 causal models. Preliminary GEE analyses indicate that children's performance is not significantly different between CF and FH conditions, Wald $X^2(1) = 0.53$, $p = .466$, nor between models, Wald $X^2(2) < 2.4$, $p > .13$. In both conditions, children's performance was better than chance for the common effect model ($p = .001$), but not for the common chain or common cause models. This is surprising in light of previous findings that children have more difficulty answering CF questions about overdetermined (common effect) events than single-cause events (Rafetseder et al., 2013). The results indicate that children can reason causally before being able

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to reason about hypothetical interventions, and point to commonalities in counterfactual and future hypothetical reasoning about the same events. Follow-up studies will examine the relation between counterfactual and future reasoning within-subjects and using different types of causation (e.g., psychological).

S8.3 Saving for the future: Episodic future thinking and delay of gratification for real versus hypothetical rewards

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Boyer (2008) has argued that episodic future thinking (EFT) facilitates prudent decision-making, suggesting the developmental hypothesis that the emergence of EFT helps children become better at delaying gratification. However, virtually all of the studies to date on EFT and decision-making have been with adults and have used entirely hypothetical monetary rewards. We will report a developmental study that examined the relation between (EFT) and children's ability to delay gratification for either real or hypothetical rewards. Participants were 131 children aged 7-to-11-years. They completed a Delay of Gratification (DoG) task, a Delay Discounting (DD) task, an EFT Interview, and a subjective temporal distance judgment task, as well verbal and non-verbal IQ measures. The DoG task involved deciding whether to take an immediately available small real reward (e.g., stationery items, candy), or to wait for a larger reward after a delay of 1 day, 1 week, or 1 month (4 trials per delay). The computerized DD task involved purely hypothetical monetary rewards, with participants deciding to wait for a larger reward over various delay periods ranging from 1 week to 3 months. Thirty-one participants were removed who did not produce systematic DD data (Johnson & Bickel, 2008). For the remaining participants, model-based Area Under the Curve was calculated; this serves as a measure of performance on the DD task. In the EFT interview, children were asked to describe particular future events that they were going to participate in, two for each of three periods of time in the future (tomorrow, next week, a few months' time). The extent to which children described particular future episodes was coded using the episodicity scoring system described by Coughlin, Lyons and Ghetti (2014). The subjective temporal distance estimation task involved participants making judgments about how far away a variety of time points in the future felt to them. We found that performance on the DoG task was strongly correlated with that on the DD task even when controlling for age and IQ ($r_{\text{partial}} = .41$, $p < .01$). Episodicity scores for the three future time periods were only weakly correlated, and showed differential relations with other measure. Regression analyses explored the predictors of DoG or DD performance. The only significant predictors of DoG performance were age and the IQ measures, whereas neither of these measures significantly predicted DD performance. Rather, DD performance was predicted by episodicity scores for the few months' time period and by performance on the subjective time estimation task. Our findings suggest that although there is a relation between children's ability to wait for real versus hypothetical rewards, these appear to be separable skills that are related to different processes. The ability to engage in EFT was only a predictor of performance on the DD task in which children made decisions about hypothetical rewards. These findings cast doubt on the extent to which EFT plays a role in facilitating children's delay of gratification in situations in which the nature of the future larger reward is concrete and visually available. Rather, EFT may be more important in facilitating the imagining of an abstract future.

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Symposia 9 – Children's understanding of social hierarchies and interventions to reduce status prejudice

S9.1 Powerful but mean: Developing a nuanced conceptualization of the wealthy

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Past work suggests that children have an overly rosy view of rich people: they prefer the rich, attribute competence, warmth, and popularity to the rich, and expect them to share more with others (e.g., Ahl & Dunham, 2017; Horwitz, Shutts, & Olson, 2014; Li, Spitzer, & Olson, 2014; Shutts, Brey, Dornbusch, Slywotzky, & Olson, 2016). Such effects seem consistent across development (from age 4 to 9; or even to age 14, e.g., Sigelman, 2012), but many could stem from valence-matching or halo effects, in which children simply associate the rich with positive attributes without having any deep understanding of wealth or the wealthy (e.g., they merely think that those who have nicer stuff are nicer). Also, past work has often employed questions closely related to the possession of resources (e.g., popularity or resource-sharing), meaning that we know much less about how judgments of the wealthy extend to other domains. In two studies (total N = 164), we introduced 4- to 12-year-old children to novel social groups that differed in wealth and measured attitudes, stereotypes, evaluations, behavioral expectations, perception of inequality, and understanding of the link between wealth and social power. We provide the first evidence that children develop a nuanced conceptualization of wealth as they age. Results showed 1) an age-related change in pro-rich attitudes with strong pro-rich biases in 4- to 5-year-olds disappearing by ages 9 to 12; 2) a domain-sensitive evaluation system, with 4- to 5-year-olds thinking the rich are both smarter and nicer, 7- to 8-year-olds thinking the rich are smarter but not necessarily nicer (responding at chance), and 9- to 12-year-olds no longer thinking the rich are smarter and thinking that the poor are nicer; 3) resource-specific behavioral expectations: children expected the rich to donate more material resources, but with age they expected the poor to donate more time; 4) an increase in perception of inequality: 4- to 5-year-olds rated the wealth gap as fair but older children rated it as unfair; and 5) a developing understanding of the wealth-power link: starting around age 5 and increasing with age, children associated the rich with power and the poor with a lack of power (in both interpersonal interactions and control over broader, societal issues). These findings suggest that as children age they develop a more nuanced conceptualization of wealth that goes beyond mere positivity. Discussion will draw connections between these findings and previous work on children's pro-rich attitudes and expectations, and will explore how our findings might inspire new work on children's understanding of wealth inequalities and power dynamics.

S9.2 Young children and adults associate social power with indifference to others' needs

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In hierarchical societies, what do we expect from people at the top? Early in life, children use horizontal social relationships (e.g., affiliation) to predict selectivity in prosocial behavior. But it is unknown whether they believe that asymmetries in prosocial behavior are characteristic of vertical relationships (e.g., differences in social power) as well. In children's views, will powerful people look out for the less fortunate, or does high status bring indifference to others' needs? We investigated the development of children's intuitions about the prosocial responsiveness of authority figures. Four- to 7-year-old children (N=64) and adults (N=32) viewed two videos, featuring different actor pairs, in counterbalanced order.

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In both videos, one woman struggled to obtain an out-of-reach object. In the Helpful video, a second woman handed the object to her. In the Unhelpful video, the second woman observed the first woman's reach, but did not help. After each video, participants answered two questions about the two actors in it: Which woman is "in charge" (i.e., gets to make all of the rules), and which one is "nicer"? How the second woman responded to the first woman's instrumental need influenced participants' judgments about their relative authority, $X^2 = 16.67$, $p < .001$. In the Helpful condition, neither children nor adults had consistent intuitions about who was in charge (both $ps < .11$). However, in the Unhelpful condition, both age groups viewed the unresponsive actor as holding authority over the person whom she did not help (46/64 children, $p < .001$; 28/32 adults, $p < .001$). Children's responses did not vary with age. The second woman's prosocial responsiveness also influenced participants' attributions of relative niceness, $X^2 = 5.07$, $p = .024$, though this tendency was greater for children relative to adults, $X^2 = 7.38$, $p = .025$. In the Helpful condition, children viewed the helpful actor as nicer (49/64 children, $p < .001$), but adults did not (21/32 adults, $p = .110$). In the Unhelpful condition, both age groups viewed the needy actor as nicer than the unresponsive one (54/64 children and 29/32 adults, both $ps < .001$). These findings establish that, by at least the preschool years, children's intuitive theories include expectations for links between power and prosociality. Further, the judgments produced by these theories appear to be stable across development. Building from these observations, we will discuss possible trajectories of change in the specificity of children's theories--i.e., whether they are specific to the association between rule-making authority and instrumental need or whether they also predict associations between other notions of power, status, prosociality, and concern for others. We will also detail new research investigating whether these theories describe only the expected frequencies of behaviors or whether they also incorporate norms about the permissibility of an authority figure's indifference to others.

S9.3 It's the economy stupid: Economic characteristics of children's neighborhoods predict race-status covariance

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Between ages three to seven, children begin to use race to predict social status (e.g., expecting Black Americans to have fewer economic resources than White Americans: Mandalaywala, Tai, & Rhodes, 2017; Shutts et al., 2016), yet we know little about how these beliefs develop. In particular, the extent to which the racial and economic characteristics of children's communities contribute to the development of their beliefs about status has rarely been examined (Odgers & Adler, 2018). In the present study, we tested whether neighborhood-level economic or racial factors predicted: (1) whether children (3.5 - 7 years old, $Mage = 4.98$) used race as a cue to status ($N = 46$), and (2) children's evaluations of their own status ($N = 74$). We measured the extent to which children across New York City used race to predict wealth-based status (using the Houses Task: children were presented with a White and a Black child and a nicer house and a rundown house, and asked which child lived in which house), as well as whether they used race to predict social power (using the Rope Task: children were introduced to a rope with 6 pegs that could be used to assign status to target stimuli based on both access to resources and decision-making power, and were asked to place a White and a Black child on the rope). Children also indicated their own status on the second task. We extracted neighborhood-level data from the 2017 American Community Survey for each participant's residential zip-code, examining two economic factors: neighborhood income distribution (i.e., the extent to which the distribution of household incomes was skewed or normally distributed within the neighborhood) and neighborhood wealth (i.e.,

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whether the median neighborhood income fell above or below the median income for New York City); two racial factors (percent of White inhabitants and percent of Black inhabitants); and one racial-economic factor (difference in median income between White households and Black households). Only income distribution and percent of Black inhabitants predicted children's use of race as a cue to status, and only on the Houses Task. First, children living in neighborhoods with a skewed income distribution were more likely to use race to predict status than those in neighborhoods where income was normally distributed, $\beta = -1.88$, $SE = 0.87$, $z = -2.15$, $p = .032$ (Fig. 1a). Second, children living in neighborhoods with fewer Black inhabitants were more likely to use race to predict status than children living in neighborhoods with more Black inhabitants, $\beta = -7.67$, $SE = 3.90$, $z = -1.97$, $p = .049$. Finally, only income distribution predicted evaluation of children's own status; children in neighborhoods with a skewed income distribution rated themselves higher in status than children from neighborhoods with more normally distributed incomes, $\beta = -0.53$, $SE = 0.23$, $t = -2.27$, $p = .026$ (Fig. 1b). Surprisingly, this was true regardless of neighborhood wealth (e.g., whether income distribution was skewed toward affluence or poverty). These results suggest that the relative distribution of incomes across a community are more important than absolute wealth for the development of children's beliefs about race and status, as well as for their beliefs about their own status. Future studies should carefully investigate this relation further, to understand exactly what information children extract from income distribution, both about others as well as about themselves.

S9.4 What can we tell children to improve their attitudes toward low-status groups

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As children develop an understanding of the status hierarchies in their society, they also begin to prefer higher-status groups (e.g., Hailey & Olson, 2013). Since these attitudes form the basis for discrimination toward low-status groups, it is important to investigate how they can be modified. The current research compares three theoretically-grounded interventions intended to reduce children's negative attitudes toward low-status groups. The first involves "colorblind" messages, which de-emphasize group membership by focusing on similarities between groups and drawing attention to individual differences within groups (Wolsko et al., 2000). The second intervention involves "multicultural" messages, which promote learning about group differences and appreciation of these differences (Rosenthal & Levy, 2010). The third intervention consists of extrinsic explanations (that is, explanations that appeal to contextual and historical reasons), which have been shown to prompt children to judge status disparities between groups as unfair (Hussak & Cimpian, 2015, 2018). The present research examines how these different messages affect children's attitudes towards low- and high-status groups. We presented a diverse sample of 4- to 7-year-old children ($N = 110$; 38% White, 19% Asian, 17% Latinx, 8% Black, and 17% other) with two novel groups that differed in both non-status traits (e.g., preferences) as well as status (e.g., wealth). Children then heard one of three messages about these differences: 1) colorblind messages that downplayed the differences (e.g., "differences don't really matter", "deep down, they are all the same," "everyone is special in their own way"), 2) multicultural messages that celebrated the differences (e.g., "differences are what make them special," "it is important to learn about these differences," "it is a good thing that they are different"), and 3) extrinsic explanations for the differences (e.g., "they moved from a different country," "they had to start over in this new place"). Instead of an intervention message, children in a fourth (control) condition simply heard the description of the disparities for a second time. We examined the effects of the three types of messages with a broad set

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of measures: attitudes toward the two groups (i.e., warmth), perceptions of homogeneity, biological essentialism, attitudes toward the status disparity, and resource allocation behavior. Overall, the two interventions that had the largest positive impact on children's attitudes toward the low-status group appeared to be those involving colorblind messages and extrinsic explanations. For instance, both of these messages increased liking of the low-status (vs. the high-status) group compared to the control condition (p s = .010 and .008) and multicultural condition (p s = .022 and .019). However, these two messages were not uniformly superior to multicultural messages; the scores for the three interventions were similar, for example, on the homogeneity and resource allocation measures. This research provides a promising first step toward devising interventions that improve children's attitudes toward low-status groups.

Symposia 10 – The symbol-grounding problem in numerical cognition: Insights from developmental psychology

S10.1 Universal numerical rules in primates and people

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Primitive logical and perceptual processes form the basis of human cognitive development. Humans expand on those primitive processes in profound ways attributable to unique features of their genome, development, and culture. Comparative studies of people and animals, cross-cultural comparisons, and developmental analyses can reveal the relative contributions of evolution, culture, and development to human cognition. We present two studies in which we compare the performance of monkeys, human children, and adults from the US and Amazon cultures on the same numerical tasks and stimuli. In one study we investigated the representation of numerosity comparatively in monkeys, children, and US and Amazonian adults. Monkeys, 4-year-old children, and adults categorized visual arrays in an unconstrained task wherein categorization by either the numerical or spatial dimensions of the stimuli was correct. All groups showed a spontaneous bias to categorize the stimuli based on the numerical dimension but cultural variables affected human categorization - exposure to mathematics education increased the numerical bias in the Amazonian and child groups. The results suggest a universal bias to represent numerical value across humans and non-human primates, as well as a psychological interaction between formal education and numerical perception in humans. In a second study we investigated the capacity for recursion during sequential rule learning. Monkeys, 3- to 4-year-old children, and adults were trained to order four parentheses following a center-embedded rule of openA-openB-closeB-closeA, as in the sequence "[{ }]". Following training, subjects were tested with novel stimuli to measure generalization of a center-embedded rule (eg., a "(< >)" sequence). Human children and adults from the US and Amazon cultures spontaneously generalized the center-embedded rule whereas monkeys did not. Monkeys were given additional exposure to the training rule and showed evidence of recursion after 20 sessions. Working memory capacity was related to the degree of recursive rule use in humans. The results suggest that humans spontaneously apply recursive rules independently of culture and with limited experience - an ability unique to humans and not observed equally in non-human primates. However, the capacity to learn simple recursive structures is present in non-human primates. Large working memory capacity may be a developmental and evolutionary precursor to the ubiquity of recursion in human psychology, including in the domains of mathematics and language. The spontaneous representation of 'number' as an actionable property of the world and

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the capacity to learn complex rules are universal cognitive capacities shared across primate species, stages of human development, and different human cultures. Humans are unique from other primates in the degree to which they spontaneously extract 'number' from other quantitative dimensions and in their proclivity for extracting complex recursive structure from sequences. We think that these unique features of human cognition are related to their opportunities to observe numerical rules from their culture and also to their ability to "observe" rules internally in a sufficiently large working memory.

S10.2 Neural sensitivity to number word meaning before and after learning to count

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Despite decades of scientific inquiry and debate, it is still unclear how children learn the meanings of number words (see Carey, 2009 for a review). At the center of the current debate is whether children initially associate non-verbal approximate numerical magnitudes with number words to gain leverage on their meaning (e.g., Dehaene, 1997; Wagner & Johnson, 2011; Gelman & Gallistel, 2000) or whether this association occurs only later in the developmental process and therefore is not consequential for initial learning (e.g., Le Corre & Carey, 2007; Carey, 2009). To assess sensitivity to number word meaning, we measured the neural response as 3-4-year-old children ($n = 67$) engaged in a cross-modal number word-quantity comparison task. Specifically, children were asked to indicate whether a given array of 1-3 animals was more or less numerous than a number word (one, two, or three) presented immediately beforehand as event-related potentials (ERPs) were measured from the scalp. We reasoned that if children had associated approximate numerical meanings to number words, then the ERP response to the quantity should be influenced by its numerical ratio relationship to the number word, an established signature of approximate numerical processing (e.g., Hyde & Spelke, 2009; Pinhas et al., 2014). Preliminary analyses show neural sensitivity to the numerical relationship between the quantity and the number word, even in children at the earliest stages of number word acquisition (i.e., subset-knowers). Further analyses suggest that the brain response of children who demonstrated a more extensive understanding of number words (i.e., counting principle/cardinal principle knowers) was modulated by both the numerical magnitude and ordinal relationship (greater than/less than) between number word and quantity. Contrary to some accounts (e.g., Carey, 2009; Barner, 2017) and in support of others (e.g., Spelke, 2017; Piazza, 2010), these results suggest that approximate numerical meanings are associated with number words earlier in the learning process and, thus, could provide a basis by which children come to understanding the meanings of other number words. Although preliminary, these results also suggest that an important qualitative difference between children who understand more number words and those who understand less may be a sensitivity to the ordinal relationships between numbers.

S10.3 Visuospatial factors in numerosity representation: Development of math concepts from perception

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The analog representation of numerosity has been viewed too noisy to ground the precise representation of number, but its limits have not been systematically examined. Despite the inevitable covariance between numerical and non-numerical dimensions (e.g., a positive correlation between numerosity and total area), research on numerosity representation has focused on minimizing the correlation. However, controlling for non-numerical correlates of numerosities increases visual entropy

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of the display, which may extrinsically increase the noise (i.e., Weber fraction) in numerosity representation. If this is the case, the noise is not an invariant constant, but changes with non-numerical factors. In the two studies presented here, we increase the extent to which non-numerical dimensions correlate with the numerical dimension and examine the effects of three ancillary, visuospatial dimensions (normalization, concatenation, and alignment) to assess the contribution of irrelevant perceptual properties to numerical comparison. In Study 1, we investigated the influences of the visuospatial dimensions by asking 46 adults to compare two numerosities with or without controlling for the visuospatial features as well as two numerals in nine number comparison tasks. We found that the ratio effects on speed and accuracy decreased considerably with visuospatial manipulation, as did the representational noise index, the Weber fraction, for numerosity. When all visuospatial dimensions supported the numerical dimension, the noise in numerosity comparison was as small as that in numerical comparison, and the largest discriminable successors in numerosity comparison were as large as those in numeral comparison. The results suggest that the noise in adults' numerosity comparison is mostly extrinsic rather than intrinsic. In Study 2, 44 4- to 7-year-old children completed four numerosity comparison tasks, where visuospatial manipulations led to the most improvement in Study 1, along with a numeral comparison task. Children performed more slowly and erroneously and exhibited greater noise than adults in all conditions, indicating the noise-to-noiseless developmental change in numerical comparison. More importantly, the visuospatial dimensions had similar, but more substantial effects on numerosity comparison in children: children compared numerosities faster and more accurately than numerals when visuospatial properties were controlled. In addition, the Weber fraction in numerosity comparison decreased significantly with the visuospatial controls, to the degree that the noise in numerosity comparison was smaller than that in numeral comparison, and the largest successive numerosities that children could accurately compare were larger than the largest successive numerals. These findings imply that the representation of numerosity is less noisy than that of numeral in young children when the extraneous noise from non-numerical dimensions is removed. Together, we demonstrated that the noise in the analog representation of numerosity comes largely from external properties that reduce the signal-to-noise ratio and increase perceptual demands for processing of the numerical dimension. This was especially true for young children who have not gained a full understanding of symbolic numbers. Thus, under optimal conditions, there is nothing about the perceptual system preventing humans from learning the meaning of symbols through association with a large set of objects.

S10.4 Learning numbers as a system of symbols and their relations

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Numbers, like words, refer to things in the world. But also like words, numbers get their meaning not just through the represented quantities but through their relations to other numbers and the syntactic rules of the symbol system. Research on early numerical development has focused on how number concepts are grounded in the perception of referred to physical quantities. Formal teaching has also focused on how mathematical concepts can be learned via concrete manipulatives. In three studies, we provide evidence for an independent pathway to numerical knowledge that is not grounded in physical objects but is built upon the relational, syntactic structure of number symbols. Study 1: Distinct developmental trajectories for number symbols and physical quantities Studies have shown the predictive relation between perceptual discrimination of quantities and mathematics achievement.

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However, advanced mathematics at its core is not about specific quantities but the systems of relations among quantities as variables. We can generate a number (e.g., ten-gazillions) that is vastly beyond human perception of quantities because the syntax of the number system is recursive and affords infinite generalization. Using both between- and within-subject designs, we asked 475 preschoolers to identify written multi-digit numbers (or dot arrays) with their spoken names or to indicate the larger quantity between two written numbers (or two dot arrays). Preschoolers could reliably map spoken number names to written forms and compare the magnitudes of two written numbers. However, these abilities were not related to their non-symbolic representation of quantities. Study 2: Learning numbers based on the symbols themselves To provide evidence for the learnability of symbolic numbers without grounding to physical quantities, we conducted a week-long training study (N = 165) during which preschoolers saw written multi-digit numbers and heard corresponding number words embedded in casual learning activities (e.g., book reading). Participants not only learned the numbers appeared during the training but generalized how multi-digit numbers are named to novel numbers and showed a better understanding of numerical magnitudes. To further demonstrate this learning in "learners" with no prior knowledge, we trained a state-of-art Recurrent Neural Network with limited pairs of number words and written symbols. The model performed at human-level accuracy on both trained and novel numbers. Study 3: Learning numbers with relational-based manipulatives Different from dot arrays, mathematics manipulatives (e.g., base-10 blocks) have perceptual structures that highlight the structures in the number system. However, studies on the efficacy of manipulatives in teaching show mixed results. To investigate the right context for symbol grounding, 226 kindergarteners participated in a training study using various manipulatives. The effectiveness of manipulatives depends on whether the relational similarities between manipulatives and number symbols are highlighted, while extraneous features of the manipulatives are downplayed. In contrast, training with number symbols avoids such tradeoff and led to robust improvement. Overall, number knowledge can be bootstrapped from the symbol system itself--without grounding to physical objects--written numbers and spoken number words carry corresponding relational structures that contribute to the meaning of symbolic numbers.

Symposia 11 – Metacognitive development in early childhood: Mechanisms and implications

S11.1 Perceptual certainty representations are domain-general in childhood

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From an early age, children can reason about the certainty of their perceptual experiences, such as differentiating between being sure vs. unsure of how many cookies are on a plate. Two competing theories have emerged about the representational nature of perceptual certainty. Under one, certainty is represented as a mathematical transformation of the perceptual signal itself (e.g., the standard deviation of a neuronal tuning function; Maniscalco & Lau, 2014), and is therefore highly domain-specific. Under the other theory, certainty is represented in a more domain-general format (e.g., the probability of an outcome being true), allowing otherwise independent perceptual dimensions to be compared in their certainty (De Gardelle & Mamassian, 2014). While work with adults has frequently found evidence for domain-general perceptual certainty (De Gardelle & Mamassian, 2014), the developmental picture is limited and so far inconsistent with this work (e.g., Vo et al., 2014, Geurten et al., 2018). Here, in two experiments, we provide evidence that perceptual certainty is domain-general in

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children as young as six. In the first experiment, 6 – 9 year-old children perform either three perceptual discrimination tasks (Number: which side has more dots; Area: which blob is bigger; and Emotion: which face is happier), or a relative certainty judgement, in which children see two discrimination trials varying in difficulty (e.g., an easy and a hard number trial), and had to judge which of the two trials they are more certain of answering correctly. We find that while children's perceptual discrimination accuracy is unrelated across the three dimensions, that children show strong correlations across the three certainty tasks, providing evidence for shared perceptual certainty representations. In the second experiment, we conduct a more stringent test of domain-general by asking children to make within- vs. between-domain comparisons of their certainty. If certainty is truly domain-general, children should be able to compare their certainty states across perceptually distinct dimensions just as effectively as they can compare it within these dimensions. Forty-eight 6 and 7-year-olds were presented with Number, Area, and Emotion perceptual discriminations. Questions were presented in pairs – either Within-Dimension (e.g., number/number) or Between-Dimensions (e.g., area/emotion). After making the discrimination decision for each of the two trials, children reported their relative certainty in the questions ('which answer are you more sure you got right?'). Consistent with a domain-general account, children were able to compare their certainty between different perceptual task types, $t(47) = 3.73$, $p < .001$, $d = .54$, which was not different from their performance on comparisons within the same perceptual task type, $F(1, 47) = .075$, $p = .39$. Together, these results suggest that – by age six – children's perceptual certainty is represented in a domain-general format.

S11.2 Uncertainty monitoring predicts academic achievement at the transition to kindergarten
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Metacognitive development, along with other higher-order executive functions, is a driving force of children's increasing ability to engage optimal decision making. In school settings, children's ability to monitor their subjective feelings of uncertainty i.e., engage in uncertainty monitoring, when faced with difficult test questions or ambiguous instructions, is a key mechanism of self-guided learning and knowing when to seek help from a teacher or peer. Research on children's metacognition has demonstrated a robust ability by middle childhood (e.g., Lockl & Schneider, 2004) with connections to academic outcomes (Zimmerman, 1990). Until recently, the dominant position was that children's metacognitive ability was severely limited in early childhood, but newer empirical work has demonstrated that young children demonstrate uncertainty monitoring, quantified as reporting higher confidence for correct compared to incorrect responses in cognitive tasks (Coughlin et al, 2014, Lyons & Ghetti 2013). Although uncertainty monitoring in young children has been linked to judicious help seeking and response withholding, relations with early academic outcomes has yet to be established. In the current study, we sought to explore the relation between young children's uncertainty monitoring, executive functioning and academic abilities during the transition to kindergarten. Participants (N = 100, 62 female, Mean age = 67 months) came from a larger ongoing study of school readiness which recruited children enrolled in Head Start programs the year prior to kindergarten. In the fall of kindergarten, children completed a perceptual judgement uncertainty monitoring task (Lyons & Ghetti, 2013) and standardized measures of early numeracy, literacy and expressive vocabulary (Woodcock et. al., 2001). Additionally, they completed battery of executive functioning tasks, Day-Night Stroop (Gerstadt, et al., 1994), Dimensional-Change Card Sort (Zelazo, 2006), Head-Toes-Knees-Shoulders

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(McClelland, et. al., 2014), and Auditory Working Memory (Woodcock et. al., 2001). Moderate correlations were found between children's uncertainty monitoring and their performance on the DCCS as well as with early numeracy and expressive vocabulary ($r = .22 - .26, p < .05$). In a multiple regression, children's uncertainty monitoring uniquely predicted children's DCCS performance ($\beta = .27, p = .008$), early numeracy ($\beta = .24, p = .018$) and expressive vocabulary ($\beta = .27, p = .004$) above and beyond their age, ELL-status, and overall judgement accuracy on the uncertainty monitoring task. When additional measures of EF were included in the model, children's uncertainty monitoring was a unique predictor of children's expressive vocabulary ($\beta = .19, p = .024$), but not early numeracy ($\beta = .10, p = .177$) above and beyond other measures of EF. Together, these findings begin to illustrate how children's early metacognitive ability is related to broader measures of executive functioning as well as their academic abilities. Collection of six-month follow-up data is about to be completed, which will allow for examining the longitudinal relations between these measures during the transition to more formal educational environments.

S11.3 Children can monitor and control their number line estimates

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Metacognitive processes, such as monitoring and control, are integral to educational outcomes (Dunlosky & Metcalfe, 2009) because they are foundational for effective self-regulated learning (e.g., judging one's progress, requesting help, slowing down on difficult problems). Little is known about children's metacognitive abilities in mathematics, such as how accurately they judge their estimation precision. Estimation precision correlates with mathematics achievement, arithmetic performance, and memory accuracy (Booth & Siegler, 2008; Siegler, Thompson, & Schneider, 2011; Thompson & Siegler, 2010; Thompson & Opfer, 2016), which are critical aspects of math proficiency. Across three studies, Wall, Thompson, Dunlosky, and Merriman (2016) showed that 1st-4th graders accurately monitored and controlled their estimates. Children estimated numbers in a small (0-10, 100, or 1,000) and large numerical range (0-100, 1,000, or 100,000). Then, they made a confidence judgment (CJ) after each trial (i.e., not so sure, kind of sure, totally sure; Hembacher & Ghetti, 2014) and decided whether to submit their estimates for scoring (i.e., a control judgment). Children were more confident in their small- than large-scale judgments, $F(2,51)=8.94, p<.01$. Further, the majority of 1st (77%), 2nd (76%), and 4th (88%) graders submitted their small- and not large-scale packet of estimates for scoring. Control judgments for individual estimates were more strongly related to the child's confidence than to actual estimation precision, $F(1,40)=89.84, p<.01$. As a follow up to Wall et al. (2016), we trained 1st and 2nd graders in a pretest-number line intervention-posttest design and evaluated whether increasing estimation precision also increased children's CJs (Morehead, Thompson, Dunlosky, & Buerke, in preparation). Corrective feedback in the 0-1,000 range (i.e., You said 150 goes here. Actually, it goes here. You showed me where N goes.) results in rapid increases in estimation precision (Opfer & Siegler, 2007; Opfer & Thompson, 2008; Siegler et al., 2009; Thompson & Opfer, 2008, 2010, 2016) as compared to additional practice without corrective feedback (i.e., control group). It was unknown whether correct and incorrect worked examples (McGinn, Lange, & Booth, 2015) might also improve estimation precision. Children's estimation precision improved from pretest-to-posttest for the feedback group ($d=.56$) relative to the control group, replicating previous work. Further, correct worked examples ($d=.53$; Another child said 150 goes here. She was right!), but not incorrect worked examples (i.e., Another child said 150 goes here. She was wrong!), were just as effective at improving estimation precision as was feedback. Most

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important, children's metacognition was dissociated from their performance; across conditions, CJs were not significantly different from pretest ($M=2.29$) to posttest ($M=2.31$). We speculate that as children's estimates become more precise, they realize how difficult it is to be exact. Future research can investigate whether a higher dosage of distributed feedback can increase confidence. In summary, elementary-aged children showed above-chance monitoring and control, however there is still room for metacognitive improvements across development. Interestingly, children were more confident for easier/small than more difficult/large problems. Future research will investigate the cues children monitor during estimation (e.g., fluency/difficulty/familiarity)

S11.4 Should I ask for help? How children weigh their confidence and available evidence

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Children are regularly faced with situations where they can seek helpful information from others (e.g., teachers, siblings, parents) to support their memory decisions. Although asking for help may be beneficial, available helpers may not always be perfectly accurate. If one already knows the answer, asking for help may even be detrimental. Therefore, appropriate help-seeking requires evaluating the quality of one's own memory (i.e., metamemory) and comparing it against a potentially helpful suggestion. Previous research demonstrates that metamemory develops throughout middle childhood (Fandakova et al. 2017), but little is known about how children actively seek help, and whether the accuracy of the information received influences how children use it. Five- ($N=26$), 7- ($N=27$), and 9-year-olds ($N=24$) completed a yes/no recognition memory test during which they had the option to ask for help that was reliable most of the time. The help provided was in the form of a cue indicating "Likely Yes" or "Likely No" that was valid (correct) 75% of the time and invalid (incorrect) 25% of the time. Thus, children decided whether or not to seek help and whether or not to follow the suggestion. After their recognition decision, children provided confidence judgments. Additionally, during some trials no help was available in order to assess baseline memory. Across ages, we found a negative correlation between proportion of help-seeking and baseline confidence ($r=-.30$, $p=.008$) demonstrating that children who were the least confident in their answers when help was not available were the most likely to ask for help. This suggests that subjective uncertainty may contribute to individual differences in help-seeking. For trials in which help was asked, we found a significant age by cue validity interaction on recognition memory, $F(2,57)=5.09$, $p=.009$, $\eta^2=.15$. Following valid cues, percent correct was similarly high across age groups (5-year-olds $M=.89$, $SD=.10$; 7-year-olds $M=.84$, $SD=.10$; 9-year-olds $M=.86$, $SD=.21$). However, following invalid cues, percent correct was significantly lower in 5-year-olds ($M=.28$, $SD=.29$) compared to 7- ($M=.60$, $SD=.24$, $p<.001$) and 9-year-olds ($M=.54$, $SD=.32$, $p=.01$). Thus, younger children do not seem to readily identify invalid cues when they occur in a generally reliable context. We found a significant main effect of cue validity on confidence ratings, $F(1,57)=4.60$, $p=.04$, $\eta^2=.08$, such that confidence was higher following valid ($M=1.20$, $SD=.52$) compared to invalid ($M=1.11$, $SD=.61$) cues. Additionally, there was a significant main effect of age, $F(2,57)=3.84$, $p=.03$, $\eta^2=.12$, such that confidence was significantly lower in 9- ($M=0.90$, $SD=0.56$) compared to 7- ($M=1.25$, $SD=0.42$, $p=.02$) and 5-year-olds ($M=1.33$, $SD=0.59$, $p=.03$). These results suggest that children's metamemory was sensitive to cue validity and they appropriately decreased their confidence following invalid cues. However, 9-year-olds had significantly lowered confidence overall suggesting they recognized that their confidence should be generally low in situations where they needed to seek help. Overall, older children are more likely to appropriately consider their own memory against a reliable, but not perfectly

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accurate, suggestion compared to younger children. Additionally, only older children lower their confidence after asking for help, suggesting that they recognize that needing help signals risk for error.

Symposia 12 – Is that so? How children evaluate claims and conjectures

S12.1 The development of epistemological understanding: Exploring individual differences and potential mechanisms of change

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A learner's epistemological understanding--or reasoning about the nature of knowledge--has important implications for critical thinking (Greene, Sandoval, & Bråten, 2016). Children's intuitive epistemology is often described as strictly absolutist, i.e. they regard knowledge as simple, certain, and objectively true (Kuhn et al., 2000). However, recent work calls this view into question. Parents' epistemological understanding predicts children's emphasis on evidence in scientific conversations (Luce et al., 2013) and their evaluations of reasoners' competence (Suárez & Koenig 2015; 2016). Thus: 1) How varied and sophisticated is children's epistemology (Studies 1 & 2), 2) What cognitive and parental factors are associated with variations in children's epistemology (Study 1) and 3) Might children's epistemological understanding develop within the context of conversation with an adult (Study 1)? Study 1: Fifty-three 6-7-year-olds participated in a within-subjects study that characterized individual differences in epistemological beliefs at baseline and tested if an adult's "epistemological scaffolding" intervention would promote more sophisticated beliefs at posttest. In each phase children saw 3 vignettes in which 2 characters disagreed about an issue with no clear answer and answered questions about the cause of the disagreement, how it might be resolved, and if there could be truth to the claims. The issues were one resolvable question of fact ("Objective"; e.g. are there dark clouds outside), one issue of interpretation ("Mixed"; e.g. does an exotic animal make for a good pet), and one potentially unresolvable matter of taste ("Subjective"; e.g. is a painting pretty). Children's responses to each issue were coded as Absolutist (truth is objective & claims are either right or wrong), Multiplist (claims are subjective opinions which cannot be right or wrong), or Evaluativist (knowledge is a subjective mind's interpretation of objective facts). During the intervention an adult scaffolded children's ability to reason in an Evaluativist manner by offering alternative ways of thinking and prompting children to reflect on their reasoning. Children adjusted their responses based on the issue (Fig 1): Objective issues elicited more Absolutist responses, Subjective issues elicited more Multiplist responses, and Mixed issues elicited more Evaluativist responses. Notably, ~40% of children held Evaluativist perspectives for subjective issues, despite findings that even adults struggle to acknowledge how matters of taste can be evaluated on objective criteria (e.g. judging music based on pitch; Kuhn, et al. 2000). Furthermore, even after controlling for children's verbal IQ, children's tendency to make Evaluativist judgments was negatively related to parents' Absolutist judgments and SES. The intervention significantly reduced Absolutist judgments and increased Evaluativist judgments in real time, but these effects did not persist at posttest (Fig 2). However, individuals who were less Evaluativist at baseline were more likely to show increases in their Evaluativism. Study 2: Pilot data on 4-5-year-olds suggest that preschoolers tend to be more Absolutist than 6+ -year-olds, but are less Absolutist regarding matters of personal taste. Thus, children are not strict objectivists. Rather, there is considerable inter- and intra-individual variation in their philosophies of knowledge reflecting age, cognitive skills, parent beliefs, and context.

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S12.2 "How do fish breathe underwater?": Young children's ability to discriminate between different quality explanations regarding biological phenomena

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By the preschool years, children know some facts about biology (e.g., cheetahs run really fast), but less is known regarding what children understand about the mechanisms that support those facts (e.g., how it is that cheetahs can run really fast). Three experiments examined the kinds of explanations children accept in response to how questions about animals. In Experiment 1, 4-, 5-, and 6-year-old children (N = 59) were asked how questions about biological processes in animals and were asked to rate four responses to those questions: mechanistic explanations, teleological explanations, circular explanations, and non-explanations. Results suggested that only 6-year-olds, but not 4- and 5-year-olds, distinguished between the explanations, with mechanistic explanations rated as better at answering questions than the other explanation types ($ps < .007$). Further, 6-year-olds recognized that non-explanations were worse at answering questions than the other explanation types ($ps < .01$). Children's verbal intelligence and biological knowledge (Mechanistic Explanations: $p = .17$, Non-Explanations: $p = .31$) did not predict their ratings of different explanation types over and above the effect of age (Mechanistic Explanations: $p = .001$, Non-Explanations: $p < .001$). To better understand the reasons for the poor performance of 4- and 5-year-olds in the first study, Experiment 2 focused on examining whether young children would better evaluate explanations in a different task and/or in a different domain. Four- and 5-year-olds (N = 45) were asked to sort mechanistic explanations and non-explanations into boxes that were labeled "Helpful" and "Not Helpful" in response to causal how questions about biological processes about real-world situations. Results demonstrated that 4- and 5-year-old children were accurate in sorting biological mechanistic explanations ($p < .001$), situational mechanistic explanations ($p = .05$), and situational non-explanations ($p = .005$). Children had difficulty, however, accurately sorting non-explanations in the biological domain ($p = .25$). Results suggested that children who were higher in verbal intelligence and biological knowledge were more accurate at sorting non-explanations in the biological domain ($ps < .05$). There were domain differences in children's sorting ability in that children were more accurate in sorting mechanistic explanations in the biological domain and more accurate in sorting non-explanations in the situational domain. A third ongoing experiment (current N = 32) follows up on these findings, adding in a measure of executive function skills to better understand the role of individual differences in how children evaluate explanations. In addition, children are engaged in a free recall memory test to examine whether they remember more detail from the mechanistic explanations or the non-explanations they are given. Results from this experiment will provide a clearer picture of how individual differences play a role in children's explanation evaluation abilities in the biological domain and will provide information regarding more long-term impacts of children's explanation evaluation abilities. Overall, this work helps inform us about how preschoolers make sense of and reason about scientific information. Implications for formal and informal science learning will be discussed.

S12.3 Children flexibly evaluate facts and conjectures

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What epistemic practices support the discovery of new ideas? Although young children use many criteria to evaluate claims (e.g. prior probability, evidence, simplicity, informants' credibility, etc.), the preeminent criteria of any hypothesis is that it provides an answer -- at least in principle -- to the question at hand. Here we look at whether children prefer unverified conjectures even to known, established facts when the former answers an otherwise unresolved question and the latter does not. In Experiment 1, four to seven-year-olds (N=98) were presented with questions that either could or could not be answered by appealing to facts provided in a story; children of all ages appropriately preferred facts for questions with known answers and unverified, but appropriate, conjectures for questions with unknown answers. Because the forced choice design could not tell us whether children preferred conjectures for questions with unknown answers or succeeded simply by rejecting irrelevant facts, in Experiment 2 four to five-year-olds (N=96) were asked to rate each response individually. We also included a condition where conjectures were prefaced with "I don't know, but maybe ...", thus emphasizing their speculative nature. Replicating Experiment 1, children rated facts higher for questions with known answers and rated conjectures higher for questions with unknown answers. In contrast to previous research in selective trust, adding uncertainty markers did not change these ratings. Thus, by age four, children reliably evaluate conjectures based on how well they answer the question. In Experiments 1 and 2, the conjectures, although unverified, did not contradict any information provided in the story. In real life however, relaxing a commitment to our prior beliefs might help us answer otherwise unresolved questions. Indeed, it is precisely such contexts in which unverified conjectures may be most able to help us shift perspectives and entertain genuinely new ideas. In Experiment 3, we tested adults' (N=35) and four to five-year-olds (N=21) willingness to accept conjectures that were explicitly in tension with information in the story. Participants rated four conjectures: a claim that was probable and satisfying given the story, a satisfying (but improbable) claim, and two unsatisfying responses varying in probability. Adults endorsed the satisfying but improbable claim as often as the probable one (while correctly rejecting the inappropriate answers); by contrast, preschoolers endorsed the probable claim that answered the question but rejected the improbable claim that answered the question along with the inappropriate answers. An ongoing follow-up (N=25) finds similar results among preschoolers even when the most likely conjecture is not included -- and finds that older children (6-7-year-olds) accept the unlikely but satisfying answer at similar rates to adults, suggesting a developmental change in the ability to prioritize question-answer fit over prior beliefs when evaluating conjectures. Collectively, the results suggest that while children recognize the value of reliable information, they may put an even higher value on answering questions. Such "cognitive pragmatism" may be critical to innovation and discovery.

Symposia 13 – Contributions of naps to sleep-dependent memory consolidation in infancy and early childhood

S13.1 Changes in sleep-dependent consolidation in infancy with development

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Previous research on sleep-dependent memory formation in infancy suggests that naps protect memories from greater loss than occurs during wakefulness but do not stabilize specific details of the memory. Here we investigate whether naps contribute to greater stabilization of a memory in older, more mature infants. In prior work, 15-month-olds heard phrases from an artificial grammar containing

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two nonadjacent dependencies (NADs), e.g. "vot-kicey-jic, pel-wadim-rud, pel-puser-rud," where "vot-X-jic" forms one NAD, and "pel-X-rud" forms the second (Gomez et al, 2006). In the 4 hours after training, infants either napped or remained awake then were tested using the HTP Procedure. On half of the test trials, infants heard familiar phrases from training (e.g. vot-X-jic, pel-X-rud). On the other half of the test trials, infants heard unfamiliar phrases from another grammar, violating the NADs from training (e.g. vot-X-rud, pel-X-jic). Infants in the No-nap groups discriminated familiar from unfamiliar strings after 4 hours (Gomez et al., 2006) but not 24-hours later (Hupbach et al., 2009). The nap groups showed generalization, looking longer to trials consistent with their first test trial versus trials from the other grammar 4 and 24-hours later, suggesting loss of the specific vocabulary making up the NADs from familiarization but not that there was a relationship between the 1st and 3rd words in phrases. To assess how retention of NADs develops, we tested older 18-month-olds using the same procedure. Now infants who nap discriminated familiar phrases ($M = 7.75$ sec) from unfamiliar ones ($M = 6.58$, $p < .05$) indicating that at 18 months, sleep stabilizes memory and prevents loss of detail. We also investigated whether infants could extend their knowledge of the learned NADs to completely novel vocabulary. Infants first listened to a NAD language with phrases such as guf-X-zam/miv-X-fop and napped in the four hours between learning and test. On half of the trials, infants heard phrases containing vot-X-jic/pel-X-rud NADs. The other half of test trials contained phrases from another grammar with opposite NADs (vot-X-rud/pel-X-jic). If infants could extend their knowledge of NADs to the grammar they hear in the first test trial, then they would learn the dependency in that trial and use it to guide their looking for the remaining trials. Indeed, 18-month-olds looked longer to trials consistent with the first test trial ($M = 6.99$ s) versus trials inconsistent with that grammar ($M = 5.85$ s $p < .05$). Thus, by 18 months, sleep stabilizes memory such that infants remember the specific NADs heard during training. Moreover, infants can recognize the same grammatical rule presented in completely novel vocabulary. Comparing these findings with our published data on 15-month-olds, we see a shift in sleep-dependent memory formation. At 15-months, sleep promotes generalization potentially due to loss of detail. At 18-months, sleep promotes a stable and specific representation, flexible enough to apply to new vocabulary.

S13.2 The role of naps in source memory for similar and distinct objects in preschool age children
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Naps play an important role in retention with much work investigating memory for distinct items. However, the difficulty children encounter in keeping source memories separate varies for similar and distinct objects with sources for distinct objects easier to remember. We investigated the extent to which naps preserved source memory as a function of age for similar and dissimilar targets. Children ages 3.5, 4.5, and 5.5 years learned associations between specific puppets (Mr. Raccoon and Mr. Bunny) and highly similar or highly distinct objects to a criterion of 75% accuracy. They then participated in a memory test for the associations after 15 minutes or after a 24-hour delay. Some children napped in the 4-hour interval after training, before experiencing nighttime sleep. Children exhibited equally high source memory for distinct objects when tested 15 minutes after training. Age group means ranged from 84.85% to 100%. In contrast, source memory for similar objects ranged from 61.43% to 79.03, with 3.5-year-olds performing at chance, $t(34) = 1.49$, $p = .15$. Children exceeded chance responding by 4.5 years, $t(32) = 4.16$, $p = .00$. Having established baseline 15-minute delay retention at 3.5 years, we next asked how naps at this age supported long-term retention. Children napped or not in the 4-hour interval after training and were tested 24 hours later. Children who napped showed excellent source memory

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for similar (90%) and distinct objects ($M=95\%$). Children who did not nap showed much greater loss of source memory for similar (59%) compared to distinct objects (81%). Thus, the nap protected source memory for similar and distinct targets over a 24-hour delay. Finally, we investigated source memory after a 24-hour delay in 4.5- and 5.5-year-olds who no longer napped on a regular basis. Although children showed robust source memory for distinct objects at ages 4.5 ($M=73\%$) and 5.5 ($M=89\%$), source memory for similar objects did not exceed chance at 4.5 ($M=60\%$), $t(25)=1.04$, $p=.31$, and 5.5 years ($M=67\%$), $t(17)=1.46$, $p=.16$. In sum, naps play an important role in stabilizing preschooler's source memories. Although children who do not nap after learning retain fairly robust source memory for distinct objects regardless of age, naps played a crucial role in source memories for similar objects throughout the preschool-age period.

S13.3 Contributions of naps to sleep-dependent memory consolidation in infancy and early childhood
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Sleep supports learning in preschool children. For instance, using a visuospatial task, we demonstrated that performance following a nap was greater than performance following an equivalent interval awake (Kurdziel et al., 2013). Moreover, this improvement was specifically associated with sleep spindles, bursts of EEG activity that may reflect underlying memory replay. While it is possible that spindles in naps may support other forms of declarative memories, visuospatial memories may be unique in that the spatial component makes the memories more receptive to hippocampal replay mechanisms. Thus, this spindle benefit may be specific to spatially-dependent declarative tasks. To begin to examine whether sleep spindles benefit other forms of declarative memories, we created a storybook learning task. At encoding, children were read four 10-page storybooks describing activities typical for a preschool child (e.g., baking cookies). Subsequently, during immediate recall, children were given picture cards depicting scenes from the story and asked to place the story in order without feedback. Polysomnography (PSG) was then applied to the child who then either napped (nap condition) or spent an equal amount of time awake engaged in quiet activities (wake condition). Following the nap/wake period, children participated in delayed recall, in which they were once again given the picture cards and asked to put the story back in the correct order. Children engaged in an additional recall session 24 hours after encoding. All children participated in both the sleep and wake conditions (order counterbalanced, separated by one week). In 23 children (36-71 months), performance following the nap was greater than when the same interval was spent awake ($p = .004$). This nap-dependent benefit persisted 24-hr later ($p = .002$). Importantly, performance did not correlate with sleep spindle density as previously observed. Rather, we found a significant positive association between time spent in slow wave sleep and recall ($r = .472$, $p = .027$). The role of slow wave sleep in declarative memory consolidation has previously been observed in studies of adults. These results further support sleep's active role in declarative memory consolidation in children. Moreover, these results suggest that slow wave sleep and the underlying hippocampal system are sufficiently developed by this age. In a second study, we are considering whether this benefit extends to another storybook task, an emotional storybook task. Current results suggest that naps do not confer an equivalent, immediate benefit on memories. As we will discuss, underlying physiological processes may drive this difference. Considering that storybooks are used by both parents and educators as a method of learning in young children (Horst, 2015), uncovering mechanisms underlying early learning warrants attention. This understanding will be important for considering sleep-based interventions to better support learning.

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S13.4 Sleep-dependent memory consolidation and hippocampal development in preschoolers
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Sleep promotes memory consolidation, the off-line processing of memories that yields them stronger and less vulnerable to interference. Sleep-dependent memory consolidation is thought to reflect hippocampal-neocortical transfer of memories, a process supported by physiological events in non-REM sleep. Previous behavioral research has demonstrated sleep-dependent consolidation in young children (e.g., Kurdziel, Duclos, & Spencer, 2013). Specifically, in habitual nappers, learning was shown to be protected by an afternoon nap compared to a similar period awake. This "nap benefit" was associated with density of sleep spindles present in EEG recorded during the nap. However, how this nap-benefit and specific sleep architecture relate to development of the hippocampal-cortical network supporting memory has yet to be examined. This gap is problematic as memory, sleep, and the hippocampal-cortical network are all undergoing significant developmental change during early childhood. The objective of the current study is to examine the role of sleep and brain maturation on memory in early childhood, specifically when children transition out of naps. The central hypothesis of this work is that maturation of the hippocampus during this period results in more information being retained without interference, reducing the need for frequent consolidation, and ultimately the transition out of napping. Participants included typically developing 3- to 5-year-old children. Each child completed a visuospatial memory task in which they learned locations of objects in a grid and were assessed immediately to index initial levels of recall. Then children were either wake- or nap-promoted (within subjects, order counterbalanced between subjects) and subsequently tested via delayed recall. During nap-promotion, sleep physiology was assessed via polysomnography (a montage of EEG, EMG, and EOG). T1-weighted MRI scans (.9mm3) were obtained for each participant. These scans were used to extract hippocampal subregions volumes (head, body, tail) bilaterally and intracranial volume (ICV) using a rigorous combination of automated and manual processing tools. Preliminary analyses include data from 18 participants (9 male, Mage=45 months, SD = 5 months). Results suggested, after controlling for effects of age and sex, learning was shown to be protected by an afternoon nap compared to a similar period awake and that this "nap benefit" was associated with density of sleep spindles, $r(10) = .47$, $p = .12$. Although this finding currently fails to reach conventional levels of statistical significance, it is consistent with previous work (Kurdziel et al., 2013) and is from a small number of the total expected participants (expected $n = 32$). Results also showed relations between sleep spindle density and both left and right hippocampal body volume, $r(7) = -.91$, $-.86$, $ps < .001$ respectively. This novel finding supports the suggestion that maturation of the hippocampus results in more information being retained without interference, reducing the need for frequent consolidation, as indexed by sleep spindle density. Data collection is ongoing and will be complete by CDS 2019. This is the first investigation to show relations between sleep spindles and the hippocampus in early childhood. Future analyses will examine relations between memory, sleep, and hippocampal volume in a larger sample.

Symposia 14 – The scope and roots of children's surprise-based learning

S14.1 Expectations and learning from non-solid substances

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Research has confirmed that infants have knowledge of how objects behave and interact through studies using looking paradigms (Spelke, et al., 1992) and action tasks (Hespos & Baillargeon, 2006, 2008). Stahl and Feigenson (2015) demonstrate something new: Infants not only have early object expectations, but this knowledge can motivate them to explore and to learn about the objects. In this study, we test whether this is also true in a new domain - non-solid substances. As adults, we have different reactions to, and expectations about, solids and non-solids. For example, you will have different results if you try to pick up a piece of yogurt than when you pick up a piece of toast. But how do we end up with these expectations? Initial studies using looking paradigms suggest that 5-month-old infants can anticipate how substances will behave and interact (Anderson et al. 2018; Hespos et al., 2009; 2016). Do infants also use violations of this substance knowledge to guide exploration? This study investigated how infants act on substances and what infants do when the behavior of a substance contradicts their current beliefs. We presented 12- to 14-month-olds four items: a solid object (solid consistent), a similar-looking non-solid item (solid inconsistent), a bowl of water (liquid consistent), and a bowl filled with gel beads that look like water (liquid inconsistent). We asked: (1) Do infants plan distinct actions for solids and non-solids? (2) Does violating these expectations lead to an opportunity for learning, with infants spending more time exploring an item that behaves inconsistently? We found that knowledge of both object and substance properties manifests in distinct infant actions. On their first approach, infants' responses were based on an item's visible object or substance properties. For example, when infants received a shape made of kinetic sand that looked solid but fell apart when touched, 53 of 64 infants used a solid appropriate action (e.g., pincer grip) on their first touch. When presented with a bowl of gelatinous "water beads" 51 of 60 infants approached it with a substance-appropriate first touch (e.g., splash or dip). These findings answer the first question: infants had distinct expectations for solid objects and substances. The answer to the second question is also yes: infants spent significantly more time exploring stimuli that violated their expectations, whether solid or non-solid, $F(1, 57) = 24.00$, $p < .001$, $\eta^2 = .29$. Infants spent more time interacting with the solid inconsistent item than with the solid consistent one, and they spent more time interacting with the liquid inconsistent item than with the liquid consistent one. These results provide a more complete understanding of how we manage the complexities of our physical world - non-solids included.

S14.2 Violation to infant faulty knowledge induces object exploration by 7.5-month-olds in support events

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Infants are exceptional learners; they acquire rules about likely outcomes of physical events and revise these rules when events do not unfold as expected, allowing them to better predict outcomes in the future. At 7.5 months, infants acquire the proportion-of-contact rule for support events and expect an object to remain stable on top of a platform only when half or more of its bottom surface is supported on the platform. Infants responded with prolonged looking to plausible events in which a wide box remained balanced on a narrow platform when released (Wang, Zhang, & Baillargeon, 2016). The present experiments examined 7.5-month-old infants' exploration of objects after they saw the objects violated their current rule in support events. Building on previous evidence for surprised-induced exploration (Stahl & Feigenson, 2015), we hypothesized that infants would preferentially explore an object that violated the rule even if it is a faulty rule. Specifically, we predicted infants to choose to explore first and spend more time exploring the "surprising" object. In addition, we also explore and

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examined the types of behaviors that infants exhibit during the exploration. In this experiment, 7.5-month-old infants saw two pairs of support events; each pair included an expected and an unexpected event (see Figure 1), with the order of presentation counterbalanced across infants. In Pair 1, the middle 33% bottom surface of the box was supported; the box remained stationary when released (unexpected event for 7.5-month-olds) or when still held by a hand (expected event). In Pair 2, the right 33% bottom surface of the box was supported; the box remained stationary when released (unexpected) or when held (expected). Each pair of the events was followed by an exploration trial in which infants were offered the two boxes used in the preceding events to explore; the boxes were placed wide apart, allowing infants to make a choice to explore. Paired sample t-tests showed that, on average, infants spent significantly longer time acting on the box of unexpected ($M = 20.1$ sec, $SD = 12.7$) than expected events ($M = 14.2$ sec, $SD = 7.9$; $t(25) = 1.99$, $p = .05$). We analyzed infant's exploration behaviors, infant exhibited significantly more behaviors that are relevant to testing object support when acting on the box of unexpected events. They showed more sliding to drop (Unexpected: $M=4.3$, $SD=3.6$; Expected: $M=3.0$, $SD=3.3$), and holding (Unexpected: $M= 2.4$, $SD=2.9$; Expected: $M= 0.7$, $SD=1.2$) behaviors on the box of unexpected than expected event Sliding to drop: $t(25)= 2.74$, $p<.05$; holding: $t(25)=2.82$, $p<.01$). Together, the results in the present experiments support that infants' expectations of physical events, even if they are faulty, drive their actions to gather information from the exemplars to fill their current knowledge gap.

S14.3 Others' surprise as vicarious prediction error: Young children use others' expressions of surprise to guide their own attention and exploration

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Prediction error - the discrepancy between expected and actual outcomes - plays a central role in learning. In humans, detection of prediction error often manifests as an expression of surprise, leading to a range of behavioral consequences. For instance, when infants observe a surprising event, they not only look longer than when they observe an unsurprising event, but also explore more and learn better (Stahl & Feigenson, 2015). However, without relevant prior knowledge to generate expectations, a naive learner would fail to recognize an observed event as unexpected or surprising. Building on prior work on early social learning and sensitivities to others' emotional expressions, here we use looking time in infants (Study 1) and exploratory play in preschoolers (Study 2) to ask whether young learners can harness other people's expressions of surprise as "vicarious prediction error". Study 1 asks whether infants use others' surprise to infer unobservable states of the world. First we conceptually replicated prior work (Xu & Garcia, 2008; $n=28$, 12.0-17.9 months) to ensure that infants look longer at an improbable sampling outcome (a red ball randomly drawn from a box that contains mostly white and just a few red balls) than a probable outcome (a white ball from the same box). In the main study ($n=28$), the experimenter drew a sample from the box, peeked at the outcome, and expressed either happiness (Happy condition) or surprise (Surprise condition) before revealing the outcome. As predicted, infants' looking time at the probable and improbable outcomes was modulated by the experimenter's emotional expression (condition x emotion interaction: $F(1,21)=12.85$, $p=.002$, See Fig 1A); infants in the Happy condition tended to look longer at the improbable than the probable outcome ($t(3.09)=2.40$, $p=.094$, two-tailed) but those in the Surprise condition showed a reversed trend ($t(13)=-2.11$, $p=0.055$). This effect was observed only on the first trial. While preliminary, these results suggest that observing others' surprise can modulate infants' expectations about event outcomes, and even

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reverse the pattern of looking time. Study 2 asks whether preschoolers consider others' surprise and their epistemic states to guide their own exploration and discovery. Children ($n=56$; 3.0-4.9 years) saw an experimenter discover an interesting function of a novel toy. Then either the same experimenter or a naïve confederate expressed surprise while playing with the toy behind an occluder. Children explored the toy more broadly in search of a hidden function following the experimenter's surprise than the confederate's surprise, both in the first 30 seconds of play ($t(54.0)=2.97$, $p=.004$) and the overall play ($t(51.6)=3.31$, $p=.002$). See Fig 1B. Rather than indiscriminately treating surprise as an indicator of novelty, children selectively used others' surprise to draw inferences about causal functions depending on their epistemic states. Taken together, this study reveals that even young children can make sophisticated use of others' expressions of surprise to guide their own attention and exploration. The results demonstrate remarkably sophisticated abilities of infants and preschoolers to harness others' emotional expressions as various prediction error. Our work synthesizes perspectives from literature on prediction error, social learning, and emotion understanding, towards a more comprehensive science of learning.

S14.4 Violations of expectation drive infants to search for explanations

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Decades of research find that infants look longer at impossible than possible events. More recently, research has revealed that infants preferentially explore objects involved in these surprising events (Stahl & Feigenson, 2015). However, it remains unknown why infants exhibit this heightened exploration. One possibility is that surprising events increase general arousal, thereby increasing infants' post-surprise activity. Another possibility is that this exploratory behavior reflects infants' search for explanations for surprising events. Here, in three experiments with identical dependent measures we tested the hypothesis that infants' post-surprise exploration reflects explanation-seeking. In Experiment 1 we showed 20 12-month-olds a surprising event involving object solidity. Infants saw a truck pass through an apparently solid wall. Next, the experimenter rotated the wall so infants could see it fully--providing additional evidence that the wall was solid. Infants' looking at the wall was measured. Finally, infants got the opportunity to freely explore the familiar truck that had just defied solidity, versus a novel ball. As predicted, we found that infants preferentially explored the surprising object, $t(19) = 2.70$, $p = .014$, confirming that surprise motivates targeted exploration. But were infants exploring in search of an explanation for the surprising event? To find out, in Experiment 2 we showed 20 12-month-olds the same surprising event, in which a truck appeared to pass through the wall. This time, the experimenter then rotated the wall to reveal that it had a large opening in its face--thereby providing a plausible explanation for the surprising event. Infants were then given the truck and a novel ball to explore. In contrast to Experiment 1, infants did not preferentially explore the surprising truck, $t(19) = .36$, $p = .72$. Moreover, individual differences in infants' exploratory preferences were predicted by their earlier interest in the visual explanation (the wall with the opening). We found that infants who had looked longest at the explanatory information (wall with opening) demonstrated the greatest preference to explore the novel distractor object (ball) that was unrelated to the surprising event. This sharply contrasts with Experiment 1, in which infants who looked longest at the solid wall (which offered no explanation) demonstrated the greatest preference for the familiar object (truck) that had behaved surprisingly, $F(36) = 3.45$, $p = .07$ (Figure 1). Hence exploration of an object that violated expectations was abolished by providing infants with an explanation of the violation. Experiment 3 served as a

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control, in which 20 12-month-old infants witnessed the truck become stopped by the solid wall (an expected, non-surprising event). Here, as predicted, infants demonstrated no exploratory preferences, $t(19) = .78$, $p = .44$ (Figure 2). Additionally, unlike the previous two experiments, individual differences in looking at the wall after the event did not predict subsequent exploration, $F(18) = .34$, $p = .57$. Together, these findings suggest that surprise-induced exploration reflects infants' search for explanations. Additionally, infants differ in the degree to which they are able to recognize an explanation for a surprising event.

Symposia 15 – New insights on the origins of self in early childhood: Links between beliefs, behaviors, and experience

S15.1 An examination of how individual differences in parent authoritarian values and economic experiences impact 3-year-olds' inferences about speakers

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A large body of work has documented preschool-aged children's selective preference for information from individuals with a history of reliability or competence. Recent work in this field has begun to examine how individual differences in culture, parenting and economic experiences impact children's extensions of selective trust (Lucas, Lewis, et al., 2014; Reifen-Tagar et al., 2014), as well as how different types of agent characteristics impact both learning and practical decisions (Pesch & Koenig, 2018). These efforts have been conducted primarily with WEIRD populations. The current study aims to address this gap in the literature by examining how selective trust is extended by children from low socioeconomic (SES) households and how parent authoritarian values are related to these decisions. In the present study, 269 3-year-olds and their mothers were recruited. All families came from low SES homes. Children completed three versions of a selective trust task: accurate vs. inaccurate, benevolent vs. malevolent, and mom vs. stranger. In each case, children were given information about the agents (e.g. "she is smart/nice/your mom" vs. "she is not smart/mean/not your mom") and asked to make epistemic decisions (who would you like to learn from) and practical decisions (who would you like to play with, share with). Mothers completed an Authoritarianism Questionnaire, which asked them to select values they believed to be more important for their child to have (e.g. "independence vs. respect for elders"). For epistemic decisions, we found a significant effect of question type such that children were more likely to ask the smart/nice/mom agent for information than endorse the information she offered. We also found a significant effect of trust task, with children more likely to ask and endorse information provided by their mother relative to the other two trust tasks. For practical decisions, there was a significant effect of trust task, with children more likely to ask for help and share coins in the Mom selective trust task. A median split on parent authoritarianism revealed that children whose parents reported having higher authoritarian values were slightly less likely to ask for information, ask for help, and share coins with the smart agent (See Fig 1). Taken together, these data offer the first comprehensive examination of how a diverse sample of children perform on different versions of the standard selective trust task and how parent authoritarian values relates to those decisions. The results suggest that for this sample, children's epistemic decisions dissociate - they are less likely to adopt beliefs from those that they initially seek information from. In addition, we found a greater selective preference for mom compared to competent or benevolent agents who were less familiar. Children whose parents had high authoritarian values were less likely to distinguish between accurate and

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inaccurate agents across both epistemic and practical decisions. We will offer interpretations of these findings, taking into consideration how diverse experiences and parenting values are reflected in children's epistemic and practical decisions.

S15.2 American and Chinese children growing up in more authoritarian homes are less likely to empirically verify a counter-intuitive claim

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Although children often rely on what they have been told, they sometimes check counter-intuitive claims through observation and experimentation. We tested the hypothesis that American and Chinese children growing up in more authoritarian households are less likely to test such claims. We presented 167 preschool children (USA: 68; China: 103) and 132 elementary school children (USA: 64; China: 64) with five different-sized Russian nesting dolls (that were painted and unrecognizable as dolls). After asking them to indicate the heaviest one (with all children choosing the biggest doll), we randomly assigned children into two testimony conditions: in the counter-testimony condition, the experimenter falsely stated that the smallest doll was the heaviest and that the biggest was the lightest, while in the confirming-testimony condition, the experimenter confirmed children's intuitions that the biggest doll was heaviest. The experimenter again asked children which doll was the heaviest and then left, giving children an opportunity to seek empirical evidence by picking up the dolls in her absence. Before leaving, the experimenter provided half of the children with a mild prompt to explore: "I'll move the dolls a bit closer to you." Most children endorsed the experimenter's claim, even when it was counter-intuitive: 78% of American children and 84% of Chinese children endorsed the testimony that smallest=heaviest. To investigate children's exploration of the dolls, we coded the number of times they picked up each doll during the experimenter's absence. Younger children picked up the same number of dolls, regardless of the testimony or prompt they received. In contrast, older children picked up a greater number of dolls when they received counter-testimony and were prompted to explore (counter-prompt condition). The number of dolls they picked up did not differ in the confirming-prompt, confirming-no prompt, and counter-no prompt conditions, Testimony X Prompt X Age Group, $\chi^2 = 4.87$, $p = .03$. Children who gathered disconfirming evidence reverted to their initial belief that biggest=heaviest. Children who did not gather such evidence continued to endorse smallest=heaviest. Parents were asked to complete a short survey assessing their endorsement of authoritarian and nonauthoritarian values (Feldman & Stenner, 1997). Parents' endorsement of authoritarian beliefs was unrelated to preschoolers' exploration of the dolls. Parents' endorsement of authoritarian values predicted the number of dolls elementary school children picked up when they received counter-testimony and a prompt to explore, $r = -.45$, $p = .023$. Elementary school children whose parents endorsed more authoritarian values picked up fewer dolls than children whose parents endorsed fewer authoritarian values. To summarize, there were no cultural differences in the impact of counterintuitive testimony. Consistent with prior research (Ronfard, Chen, & Harris, 2018), only older children sought empirical evidence in response to such testimony; and of those children, those with less authoritarian parents explored more compared to those with more authoritarian parents. These results show that individual differences associated with authoritarianism are expressed in early childhood shaping not only whose information children value (Reifen Tagar et al., 2014) but also their willingness to verify what they have been told.

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S15.3 Are presidents bossy? Boys' and girls' concepts of presidents differentially predict political aspirations

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Women in the United States are underrepresented in leadership positions across a range of professional domains. A notable example is the political sphere: since our country's inception in 1776, all 45 elected presidents have been male, and as of 2019, women account for only 23.7% of the US Congress. Why do women continue to be underrepresented in positions of political authority? Here, we test the idea that disparities in political authority can be traced back, in part, to the stereotypes about gender and authority that children are exposed to. Authority figures are typically portrayed as both agentic (e.g., assertive, dominant) and competent - traits that are, across cultures, associated with men more than women. In contrast, traits of warmth and compassion, which are often associated with women more than men, are unrelated or even negatively related to notions of authority (Fiske et al., 2002). Given that agency and competence are central to the concept of a political leader (e.g., Eagly & Karau, 2002; Heilman, 2012), gender stereotypes that associate these traits with males may signal to girls that they are not suited for positions of political authority. In the present study, we investigated the types of traits children ascribe to presidents (i.e., agentic vs. competent vs. warm) and whether endorsement of these traits as important to being president predicts children's interest in being a president when they grow up. For example, do girls who think presidents have to be agentic or competent display less interest in becoming one? To assess concepts of presidents, we asked children (N = 148, 52.7% girls; age range = 5 to 11; Mage = 7.87, SDage = 1.74) "What do presidents have to be like?" and coded all open-ended responses on the dimensions of agency, competence, and warmth. We also presented children with a series of traits that tapped these three dimensions (e.g., "likes to be in charge", "smart", "nice"), and asked them whether they think presidents should or can have these traits. Children's scores on each dimension were combined across these two measures and could range between -100 to 100 (higher scores = the trait is more central to children's concepts of presidents). To assess interest in political leadership, we asked, "Do you want to be the president when you grow up?" Affirmative answers were followed up with "Do you want to be president a little, some, or a lot?" Children's responses were combined across these two questions and ranged from 0 (do not want to be president) to 3 (want to be president a lot). In line with our hypothesis, thinking that presidents are agentic and competent differentially predicted boys' and girls' aspirations: As Figure 1 (panels A and B) reveals, the more girls thought presidents needed to be high in agency and competence, the less interested they were in this role; in contrast, the more boys thought presidents needed to be high in these traits, the more interested they were. None of these patterns varied by age. With respect to warmth, thinking of presidents as warm increased with age and positively predicted both boys' and girls' interest in being president (Figure 1C). These findings provide preliminary support for the idea that gender disparities in politics may have roots in children's concepts of political authorities as competent and agentic. Interventions to promote women's involvement in political leadership should consider targeting young children.

S15.4 Cultural differences in deference to authority and social convention are apparent already in childhood and contingent on parent authoritarianism

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Individual and cross-cultural differences in sociopolitical authoritarianism have traditionally been assumed to only manifest in young adulthood. Recent work, however, suggests that related individual differences are apparent already in young children in a manner consistent with parent sociopolitical authoritarianism. In the current study we extend this work by focusing on children's explicit expressions of authoritarian orientation - preference for deference to authority and social convention, and examining whether cross-cultural differences in authoritarianism among adults are also evident already in childhood. To test this, we recruited 170 mother-child (4-8-year-old) dyads from two cultural groups in Israeli society that differ in their level of authoritarianism: ultra-orthodox Jews and secular Jews. We expected that to the extent that cultural differences are apparent already in childhood, ultra-orthodox children would be higher both in their endorsement of deference to societal authority and in their intolerance of deviance from social convention relative to secular children; and that such patterns would correspond to differences in mothers' level of sociopolitical authoritarianism. Mothers completed a survey assessing their sociopolitical authoritarianism. Children completed two tasks both presented in the form of a children's story: in one they evaluated the legitimacy and desirability of a character making individual choices independent of the recommendations of 'the king who rules the land' (preference for deference to authority); and one evaluating a group member who defies a group convention (intolerance of deviance). Children's responses were recorded on a six-point scale. As expected, we found that ultra-orthodox mothers were significantly higher in authoritarianism than secular mothers. Importantly, ultra-orthodox children were significantly higher both in their endorsement of deference to authority and in their intolerance of social deviance relative to secular children. Furthermore, across the two groups, both child deference to authority and child intolerance of deviance was strongly associated with mothers' sociopolitical authoritarianism. Associations were similarly strong across cultural group as indicated by non-significant interactions between mother authoritarianism and group, for both child variables. These findings show that cultural differences in the endorsement of authoritarian attitudes are apparent already in young children and correspond to parent differences in sociopolitical authoritarianism. The findings suggest that parent authoritarianism shapes not only their children's sensitivity to cues related to authority and convention as earlier work has demonstrated, but also to children's proto-political orientation.

Symposia 16 – Young children's scientific theory building and knowledge acquisition

S16.1 When do fantastical stories benefit young children's learning?

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Educational stories often contain both possible and fantastical information. How do young children decide what to learn? Research suggests that children are more likely to learn from a realistic story than a fantastical one (e.g., Richert et al., 2009; Walker et al., 2015), since the similarity between the realistic story and reality facilitates transfer. However, other work hints that fantasy may lead to superior learning under certain circumstances (Weisberg et al., 2015; Stahl & Feigenson, 2017). In four studies, we examined children's learning from realistic vs. fantastical stories to determine when each type of story may be most beneficial to learning. Studies 1 and 2 confirmed that children do not always learn better from realistic stories. In both studies, preschoolers (Mage = 4;9) were presented with a novel fact embedded in a story that was either fantastical or realistic. In Study 1, children who heard the fantastical story were marginally more likely to say the novel fact was true than children who heard a

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realistic story: $\chi^2(1, N = 40) = 2.85, p = .09, \Phi = 0.27$. Study 2 also found that children who heard the fantastical story were marginally more likely to say the novel fact was true: $\chi^2(1, N = 72) = 3.50, p = 0.06, \Phi = 0.22$. These studies suggest that fantasy elements can help learning. Why might this be the case? Work with infants suggests that physically impossible events may lead to better learning by increasing attention and prompting learners to seek explanations (Stahl & Feigenson, 2015). To test these claims, Study 3 examined children's learning from stories that contained events that violated either physical or biological laws. Preschoolers (Mage = 4;10) heard a story with information about two science principles (inheritance and balance) and were pre- and post-tested on each. The stories contained events that were physically impossible (e.g., walking through walls; $n = 34$), biologically impossible (e.g., aging backwards; $n = 33$), or possible ($n = 34$). The balance principle was difficult for children to learn; scores on this problem were significantly lower than the inheritance principle at both pre- and post-test. Children showed significant learning of this difficult principle only when the story contained no impossible events: $t(33) = 2.36, p = .02, d = 0.40$. However, for the inheritance principle, children showed significant learning only when the story contained physically impossible events: Pre/post-test difference scores in this condition were significantly different from zero, $t(29) = 3.91, p < .001, d = 0.71$. Study 4 (current $n = 67$) aims to replicate this effect while also bringing the difficulty of the balance principle in line with the inheritance principle. These studies add to a growing body of work showing that some types of fantasy - physically impossible events - can benefit children's learning. Further, they suggest that fantasy elements benefit learning only in particular circumstances. When a problem is difficult and children are uncertain about it, they may default to quarantining information from fantastical sources to avoid learning inaccurate information. However, for information that is within children's zone of proximal development, physically impossible events may heighten their attention and lead to deeper processing.

S16.2 How shared book-reading can boost children's scientific discourse and understanding

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Children's understanding of unobservable scientific entities (e.g., electricity, germs) largely depends on testimony from other people, as this knowledge cannot be acquired solely through firsthand observation (Harris et al., 2018). One form of testimony is parental explanations that highlight the mechanism underlying a scientific entity. Mechanistic explanations are particularly helpful in promoting children's conceptual understanding and importantly, help learning transfer to novel situations (Lombrozo et al., 2018). However, mechanistic explanations are rare in parent-child conversation (Authors, under review), raising the question of how best to encourage these conversations. The current study aimed to boost parent-child mechanistic conversation by embedding mechanistic explanations about electricity into storybooks. We were particularly interested in whether this manipulation increased mechanistic language during a subsequent scientific activity, and whether it also improved children's understanding of electricity's mechanism. Four- to five-year-old children ($N=58$) and their parents participated at a science museum and preschools in the United States. During the book-reading phase, parents read a researcher-developed storybook to their children, with eight explanations about electricity embedded within the story. Half of the dyads read books with explanations that referenced mechanisms of electricity (It's a kind of energy that make things move, light up, or get hot), while the other half read books containing non-mechanistic explanations (It's a kind of energy that we can't always see but is very powerful). Otherwise, stimuli in each condition were matched for plot, length, and

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linguistic complexity. Next, during the dyadic phase, the dyad worked collaboratively to assemble electrical components of a circuit toy so that a light would turn on. Dyadic speech was transcribed using CLAN software (MacWhinney, 2000). Coders then identified whether speaker utterances contained evidence of mechanistic reasoning (e.g., We need to connect these pieces in a circuit). During the learning phase, children first independently assembled a novel circuit, and second, answered comprehension questions to gauge their understanding of electricity's mechanism. During the dyadic phase, participants assigned to the mechanistic condition ($M=94\%$) were more successful at completing the circuit than the non-mechanistic condition ($M=65\%$), $B=3.01$, $SE=1.12$, $p=.007$. During this phase, mechanistic dyads also produced significantly more mechanistic language ($M=7.0\%$ of their total utterances) than non-mechanistic dyads ($M=4.0\%$), $F(1,54)=4.35$, $p=.04$, $d=.08$. Significant condition differences were also observed during the learning phase such that children in the mechanistic condition were more successful at the independent circuit task ($M=70\%$) than children in the non-mechanistic condition ($M=38\%$), $\chi^2(1)=7.60$, $p=.008$. There was no main effect of condition on children's comprehension, $B=-0.30$, $SE=0.50$; $p=.54$. However, we observed a significant interaction between condition and dyadic mechanistic language on comprehension: children in the mechanistic condition were more likely to successfully comprehend the mechanism if they participated in more mechanistic conversation during the dyadic phase, $B=-32.91$, $t=2.28$ $p=.02$. These results suggest that everyday routines such as book-reading can help support children's scientific discourse and understanding.

S16.3 Science in the classroom: Addressing science misconceptions in the early years through books and play

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In adopting teaching methods for young children it is important to capitalize on activities that are both enjoyable to children and effective for learning. This is particularly important for science education, as children can be especially resistant to revising science misconceptions (Pine, Miesser, & St. John, 2001). Revision of incorrect beliefs is a gradual process and conceptual change requires prolonged and diverse experiences with the concept in question (Vosniadou, 2013). Joint picture book-reading is an activity that children enjoy and also learn from (Venkadasalam & Ganea, 2018). Play can also be used in the classroom as a way of learning new information. In this research we investigated whether combining book reading with two types of child-focused play, either guided or free-play, leads to differential learning outcomes. In free play, the child has complete autonomy, whereas in guided play, the adult scaffolds learning activities through prompts. We recruited two classes of kindergarten children (ages from 3 to 6) to participate in the intervention. We developed books and activities on two different physics concepts: falling objects and sinking and floating. Children in each class were randomly assigned to either a Picture Book & Guided Play condition or a Picture Book & Free Play condition for each concept, and their condition was switched for the second concept. The intervention for each concept took place in small groups (5 children) twice a week for two weeks. Each week, children read one book (Days 1 and 3) and completed one activity (Days 2 and 4). During the guided play the experimenter provided children with prompts and explanations. For the free play, children were given the same materials, reminded of the picture book and given a learning goal but no guidance as to what to do with the materials. Children were individually pre-, post- and delay-tested to determine learning over time. The post-test occurred on Day 4 and the delay-test 6-to 8-weeks later. In each of the 3 test phases children were shown 4 pairs of objects. Within each set of 4 pairs, two pairs of objects were the same

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weight, and two were different weights. For each test phase, children received a different object set, but the order of these sets was counterbalanced. Children were asked to make a prediction (for falling pairs 'Would the objects fall at the same time or one faster than the other?'; for sinking and floating pairs 'Which object would sink and which would float?') and to explain their predictions. The outcome measure was children's explanations scored on a 3-point scale. A one-way ANOVA revealed no differences in pretest scores between the two conditions ($p = .414$). A 2 (condition) \times 3 (test phase) mixed ANOVA revealed no main effect of test phase ($p = .097$) or condition ($p = .143$). However, there was a significant interaction between test phase and condition ($p = .026$). Results showed that at post-test, children revised their physical science misconceptions through both conditions ($p = .399$), but children in the guided play condition retained their knowledge at a two-month delay significantly better than those in the free play condition ($p = .024$). We conclude that combining picture books with guided play is best for long lasting learning.

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Oral Abstracts

Oral Papers I

O1.1 How consequential and retributive motivations shape costly third-party punishment in young children

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People punish moral transgressions to satisfy a variety of motivations. For example, people may be motivated by retributive concerns (Kant, 2011): individuals want antisocial others to receive their "just deserts." On the other hand, people may punish because of consequentialist concerns (Bentham, 1789/2000): individuals wish to deter future harms by teaching the transgressor a lesson. Research with adults has examined which type of motivation underlies punitive behavior by manipulating whether punishment is "communicative". Specifically, punishment is either known to the transgressor and can communicate a norm (i.e., communicative punishment) and thus satisfies a consequentialist motivation. Or, punishment is unknown to the transgressor (i.e., non-communicative punishment), thereby eliminating any potential prosocial benefit from punishment (and thus only satisfies a retributive motivation) (Crockett, Ozdemir, & Fehr, 2014; Nadelhoffer, Heshmati, Kaplan, & Nichols, 2013). These studies, among many others (Carlsmith, Darley, & Robinson, 2002), find that participants are motivated to punish in both communicative and non-communicative contexts. Here, we are concerned with whether young children, like adults, are also motivated by both consequential concerns and pure retribution. Much research has documented that children at least possess an appetite to punish others--preverbal infants prefer individuals who punish antisocial targets relative to those who are nice to antisocial targets (Hamlin, Wynn, Bloom, & Mahajan, 2011). And, children engage in third-party punishment as young as three (Yudkin, Van Bavel, & Rhodes, 2019). It is unclear though whether this punitive behavior is motivated by retributive or consequential concerns. We examined this question here with 4- to 7-year-old children (N = 113). Specifically, in our study, children could punish an antisocial child who ripped up another child's drawing by preventing them from playing on an iPad, but doing so meant participants could not play themselves. Punishment either exclusively satisfied retributive motives by only inflicting harm upon the transgressor ("non-communicative punishment") or additionally satisfied consequentialist motives by teaching the transgressor a lesson ("communicative punishment"). We found that children punished significantly more in the non-communicative condition than in a control condition where the target of punishment behaved neutrally (~40% versus ~13%), and they punished almost twice as much in the communicative condition (~80%). See Figure 1. In an ongoing study (projected N = 138; current n = 101), we are seeking to replicate this effect and also to examine what mechanisms underlie children's desire to engage in retribution. Taken together, we find clear evidence that children's punitive motivations are characterized as a mixture of retributive and consequentialist. Our work coheres with past research documenting that children are willing to engage in costly third-party punishment (McAuliffe et al., 2015), even children as young as four. These findings generate a clearer understanding of the early emergence of behaviors implicated in the evolution of cooperation in humans (e.g., Balliet et al., 2011), and show that both retributive and consequentialist motives drive punishment in young children and rule in the possibility that the taste for retribution emerges early in development.

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O1.2 Being rich or poor: How inequality affects who children give to in experimental games

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Economic inequality is an uneven division of resources, where a majority of wealth is possessed by a minority of the population (Wilkinson & Pickett, 2009). Research has revealed a link between high inequality and lower prosocial behavior in adults (e.g., Côté, House & Willer, 2015). However, little research has uncovered how children experience and understand macro-inequality, and how this affects their behavior. One study by Kirkland, Jetten and Nielsen (2019) directly examined how four-year-old children experience inequality in a novel experimental paradigm. After playing a series of games with puppets, the players received tokens which could be exchanged for stickers. The distribution of tokens was either A) highly unequal or B) highly equal. Importantly, this was non-meritocratic and across both conditions children received tokens that placed them in the middle with regard to earnings. After experiencing high inequality, children donated fewer stickers to a child in need in compared to the children who experienced low inequality. However, when asked to give more tokens to the puppets, they did not give more to those who received less. Instead, they divided the points equally irrespective of prior earnings. This research uncovered that, even in an experimentally fabricated setting, high inequality can alter children's behavior. However, research suggests that an individual's position (i.e., whether you're wealthy or poor) can have a marked impact on the experience of inequality (Côté et al., 2015). Thus in the current study, we explored how children react when they are high or low earners, and how this intersects with their experience of high and low inequality. To explore this, we adapted the paradigm from Kirkland et al. (2019) in two experiments (N = 120) to uncover the role of high and low inequality, respectively. Across both experiments, 4- to 6-year-olds played a game with several puppets where each accrued tokens over time. Importantly, the association between the players' behavior in the games and the tokens awarded to them was random. In both experiments, children were either A) a high earner, or B) a low earner. However, in Experiment 1 children experienced high inequality, and in Experiment 2 children experienced low inequality. Across both experiments, children's external donation rates did not differ after being a high or low earner. However, we observed an unexpected pattern in their resource division behavior. After experiencing high inequality (E 1), children who were high earners gave more to puppets who received less. However, low earning children in high inequality gave more to high earning puppets. After experiencing low inequality however (E 2), there was no difference in children's resource division behavior after being a high or a low earner. These results suggest that, when outcomes are unequal, young children are highly sensitive to where they sit relative to others. This may result in children avoiding giving to those who earn a similar amount to themselves as this threatens their position relative to others. These results provide initial evidence that young children's experience of economic inequality can impact how they treat others. Most of the world's children will experience wealth disparities in some way, some more intensely and consistently than others. It is critical that research such as this be undertaken to better understand the social and cognitive impact this experience has.

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O1.3 What you should have done: Children's moral judgments incorporate representations of inaction

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Moral theories are frameworks for judging how others uphold the principles that bind communities together. Their roots appear early: Even infants view helping as good and hindering/harming as bad. Yet morality involves more than judgments about the rightness or wrongness of actions. It also prescribes what one ought to do; in some contexts, inaction itself is impermissible. The cognitive foundations of children's early reasoning about moral obligations are not well understood. Accounts of moral development typically take representations of a person's actions as their starting point. But reasoning about moral obligations further requires the capacity to consider situations in which a person did not act at all. This poses two challenges. First, cases of morally relevant inaction may be unmarked. Second, representations of such inaction must be capable of entering into computations similar to those that support judgments about actions. We investigated children's reasoning about one's prosocial obligation to help others. Experiment 1 asked whether preschool-age children spontaneously notice one person's failure to help another person in need, and whether they evaluate such unhelpful people negatively. Three- to 6-year-olds (N=128) viewed two videos each. Children in the Helpful condition saw one actor help another access an out-of-reach object; those in the Unhelpful condition saw her observe the other's reach but do nothing. With age, compared to actors in no-help-needed baseline videos, children increasingly evaluated the helper more positively, and the non-helper more negatively. This was evident in their play choices and actor niceness ratings from 5 years, and their selective projection of positive (e.g., "always keeps promises") and negative (e.g., "never shares") qualities by 6 years. Experiments 2 and 3 asked whether 4- to 6-year-old children recruit representations of unhelpful inaction for more complex moral reasoning. Experiment 2 (N = 80) asked whether exculpatory factors lessen children's negative evaluations of unhelpful inaction. Evaluations of inaction were unaffected by the presence of a barrier making it difficult for the actor to help; however, 8- to 10-year-olds were more forgiving of inaction when helping would be effortful. Experiment 3 (N = 96) asked whether unhelpful inaction--even if temporary--lessens children's positive evaluations of helpful action. Children viewed hesitating helpers as less praiseworthy than immediate helpers (but only by 6 years, when controlling for the duration of expressed need). Experiment 4, with 3- and 4-year-olds, uses a simplified procedure to better compare emerging evaluations of helping and not helping. This ongoing project also assesses judgments about the permissibility of unhelpful inaction, to test the hypothesis that children's explicit moral theories about helping precede their spontaneous attention to unhelpful inaction. In sum, results thus far demonstrate that preschoolers spontaneously detect instances of morally relevant inaction--a disposition critical for identifying violations of obligations in a dynamic world. Moreover, representations of helpful action and unhelpful inaction support social evaluations, personal preferences, and trait projections along similar developmental trajectories; and during early-to-middle childhood, representations of unhelpful inaction participate in computations just like those supporting children's moral reasoning about overt actions.

O1.4 The development of beliefs about censorship

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What are children's intuitions about the nature of censorship? Across four studies, we examined how 5-10-year-old children think about censorship and the social and moral norms around media and communication more broadly. In all studies, we presented children with vignettes describing scenes from eight fictional movies and asked them to decide which movies should or should not be watched. The eight vignettes featured acts across four different domains (harming a human, harming an animal, harming property, and purity violations); each domain was presented once as intentional and once as accidental. In Study 1, we found that children, in deciding both for themselves and for another child, censor movies with harmful content more often than allow those same movies. Older participants also censored less often than younger participants. In addition, children censored more movies with intentional harms than accidental harms, suggesting that children are attending to the moral content of the movies. In Study 2, we examined the role of the age of the audience in censorship decisions. For each movie, participants decided whether three potential audiences (a little kid, a big kid, and a grown-up) could watch the movie or not. We found that children censor more often for younger audiences than older audiences. We also replicated our intentionality effect from Study 1, but also found that intentions matter less when picking movies for a grown-up than for either of the kids. This interaction between audience and intentionality of harm suggests that children understand that norms regarding media consumption differ based on the age of the target. In Studies 1 and 2, children often spontaneously explained their decisions based on avoiding modeling negative behavior for the audience, suggesting that children censor based on the potential effects on the audience. We hypothesized that intentional actions may be more easily modeled and copied than accidental actions and thus motivations to avoid modeling negative behavior should attend to the intentionality of the act. In Studies 3 and 4, we directly examined this motivation by assigning participants to receive a motivation to either avoid making another kid feel sad or do something bad after watching the movies. We found that the role of intentionality on the number of movies allowed was greater when participants were trying to avoid making the other kid do something bad than when trying to avoid making the other kid feel sad. Together, our results indicate that children from age 5 make sophisticated decisions regarding censorship, not only engaging in censorship of film but also demonstrating motivations to avoid modeling harmful behavior for audiences based on the intentionality of the depicted harms. Our findings have implications for both theory on children's understanding of moral and social norms but also in understanding the development of attitudes about censorship.

O1.5 Sociolinguistic development in a diverse, multilingual society: Evidence from 7- to 14-year-old children in Gujarat, India

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How does the presence of diversity in children's linguistic environments shape social associations regarding the languages one speaks? Prior research on sociolinguistic development has focused on contexts in which a small number of linguistic distinctions (e.g., speaking one English dialect versus

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another) map predictably onto distinct social features (e.g., growing up in the South versus North, or being judged 'nice' versus 'smart;' Kinzler & DeJesus, 2013). The present study traced the development of sociolinguistic associations in a more complex, multilingual environment than previous studies. Specifically, we worked with children in Gujarat, India, who spoke an average of 3.9 languages, including languages corresponding to their parents' geographic origins, languages used as common languages outside the home, and languages learned in school. 68 3rd (n=25), 5th (n=14), and 7th (n=23) graders responded to four counterbalanced blocks of questions regarding 8 languages or dialects that crossed regional, political, ethnic, and religious boundaries (Gujarati, Marathi, Hindi, Urdu, Tamil, Indian English, Standard American English, Mandarin). For all questions, students were given the option of not answering, to avoid forcing stereotypical responses. Speaker Associations. Children heard unlabeled audio samples of speakers of each language, and judged speakers' wealth, geographic origin, and religion. While 3rd-graders responded unsystematically, selective associations appeared with age (e.g., between being Muslim and speaking Urdu; being Hindu and speaking Gujarati/Hindi/Marathi; and being Christian and speaking English; all $p < .05$). The age where robust geographic associations first appeared varied substantially by language, suggesting that children were basing their responses on experience in their environments. Hindi/Gujarati voices, for example, were reliably assumed to be from Gujarat before English/Mandarin voices were reliably assumed to be foreign, or before Tamil voices were assumed to be Indian. Stereotypical Speakers. Children guessed who 'could be speaking' from among five stereotypical faces (Hindu North Indian, Muslim, South Indian, Han Chinese, and White) in response to audio language samples or language names. Consistent with prior research, children's face selections became more systematic with age (all $p < .05$). Interestingly, children showed more stereotypical responding when languages were referred to by name (e.g., who speaks Tamil?) compared to when only audio samples were played ($p < .001$), suggesting that children's stereotypes about speakers come from culturally transmitted knowledge in addition to their own experiences seeing people speak. Essentialism and Learning. Children predicted how well each face would 'come to speak [LANGUAGE],' if the person had never heard it before and had just begun studying it. Despite increased stereotyping with age (see previous section), essentialist responses regarding the learnability of different languages based on speakers' ethnicities decreased ($p < .05$), suggesting that older children understand the relation between language and ethnicity is non-deterministic. Faced with great linguistic and social variability, children track language-specific regularities, rather than generalizing across languages. This slow, selective process may be supplemented or even overridden by input from the surrounding culture, where associations may be conventionalized into stereotypes.

Oral Papers II

O2.1 Do children think that scientists are smart? The influence of gender on kindergartners' understanding and use of descriptors about science and intelligence

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Prior research shows a change after kindergarten in children's stereotypes about scientists. In the Draw-A-Scientist task, 5-year-olds drew scientists of roughly equal gender ratios, but the ratio grew to 4-to-1 favoring males once in elementary school (Miller, Nolla, Eagly & Uttal, 2018). In a 2017 study from Bian et al., kindergarten children were asked to choose a 'smart person' out of gender balanced picture

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arrays. At the end of kindergarten girls were less likely than boys to choose members of their own gender, and began to reject activities said to be only for smart children. Thus gender stereotypes are not only present even before the start of elementary school, but they are already affecting which activities girls choose. To our knowledge, no research has been conducted on children's understanding of the relation between science and intelligence. The current study sought to answer the following questions: Do kindergarten age children associate being smart with being a scientist? Are children's gender stereotypes about science and intelligence affecting which activities they choose for themselves? What factors may be related to gender stereotypes for boys and girls? 48 5-year-olds ($M=68$ mo., $F=25$, $M=23$) attending public kindergarten in rural SW Virginia participated. Tasks were adapted from Bian et al. (2017) to also include questions about science. When asked to choose the smart one or the scientist out of gender balanced arrays, girls and boys differed significantly with each group overwhelmingly choosing pictures of their own gender (smart: $t(46)=3.35$, $p=.001$; scientist: $t(46)=2.27$, $p=.01$). Boys also associated the two questions ($r(23)=.45$, $p=.05$), while girls did not. When asked if they would like to play games for smart children and for little scientists, girls were more likely to want to play the smart game compared to the one for little scientists, $t(24)=2.99$, $p=.01$. There was no difference for boys, indicating a more conceptual disconnect for girls. Finally, when examining which factors influenced children's answers, we found that parents' occupation had a specific gendered influence. While boys' likelihood to choose men as being smart was correlated with their dad's occupational prestige (the level of education their job requires, $r(23)= -.47$, $p=.05$), for girls, whether the mom was employed at all was positively related to girls wanting to play both the game for 'smart kids', $r(25)=.54$, $p=.01$, and for 'little scientists', $r(25)=.45$, $p=.05$. Girl's desire to play the game for 'smart kids' was positively correlated with mother's occupational prestige, $r(25)=.47$, $p=.05$. No cross-gender parental occupation effects were found. In conclusion, despite the disconfirming messages that girls receive about women in science such as in children's media, girls were still more likely to choose women instead of men as scientists, and did not differ from boys in willingness to engage in activities for 'smart kids' and 'little scientists'. It is possible that this may change once they enter elementary school (Miller et al. 2018). In addition, two of our tasks confirmed that boys associated science and intelligence more than girls did. Finally, parental occupation influenced boys and girls differently along clear gender lines. In this rural low SES sample, we see a compounding of socioeconomic risk whereby the restricted professional opportunities of the parents is having a direct impact on the possibilities children see for themselves.

02.2 Anticipation of social backlash and girls' interest in leadership

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Throughout the world, top decision-making positions and leadership roles are dominated by men, and research indicates that this disparity is due at least in part to gender bias. Adult women are often met with resistance and viewed as interpersonally hostile when they behave assertively (Rudman & Phelan, 2008). These assertive behaviors are seen as required for leaders and valued in men, but contradict the traditional feminine role (Heilman, 2001). Women anticipate and often seek to avoid social backlash by refraining from assertive behaviors and authority roles (Moss-Racusin & Rudman, 2010), contributing to gender gaps in leadership. The current research examined whether awareness of (and the tendency to

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avoid) social backlash in response to leader-like behaviors emerges at an early age (Haun & Tomasello, 2011). Specifically, we tested whether girls (more than boys) anticipate social backlash for leader-like behaviors, and whether they actively seek to avoid such backlash by eschewing opportunities to lead. Over time, girls' early avoidance of leader roles as a way to avoid social backlash could contribute to the underrepresentation of women in leadership. In two studies, we examined the development of beliefs about the social costs of leadership. Study 1 tested whether girls compared to boys anticipate stronger social backlash from peers for stepping up to be in charge. We read children ($n = 99$; 49 girls; ages 5-10) four stories, each featuring either a boy or a girl (between participants) who stepped up to be in charge of a group activity. Each story happened in a different setting (e.g., at the park), and each story featured a different group of children, either: (a) a small same-gender group (e.g., two girls); (b) a large same-gender group (e.g., 10 girls); (c) a small mixed-gender group; or (d) a large mixed-gender group. After each story, we asked participants four questions to gauge their anticipation of social backlash against the leader (e.g., "Would the other children like him/her more or less?"). Both girls and boys anticipated stronger backlash for other-gender leaders compared to own-gender leaders ($p = .032$), but-- importantly--girls anticipated stronger social backlash than boys overall ($p = .010$). Study 2 (data collection ongoing) was designed to test whether girls in particular avoid being in charge due to anticipated social penalties. We are presenting children (ages 5-10) with a group game in which a player may choose to be the "boss," and measuring participants' interest in being the boss (i.e., the leader), their leadership self-efficacy (i.e., how effective they think they would be as leaders), and their anticipation of social penalties and resistance from other players. Preliminary results ($n = 61$; 34 girls) suggest that anticipated social penalties may have a unique influence on girls' (vs. boys') leadership aspirations. For boys, interest in being in charge was associated only with leadership self-efficacy ($p = .001$). In contrast, for girls, interest in being in charge was associated not only with self-efficacy ($p < .001$), but also with anticipated social penalties ($p = .009$) and peer resistance ($p = .050$). As a whole, these studies provide initial evidence that fear of social backlash can influence girls' interests from an early age, discouraging the pursuit of leader-like activities and potentially contributing to the persistence of gender gaps in leadership.

02.3 Children's intergroup attitudes: Insights from Iran

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Children generally favor individuals in their own group over others, and some developmental theories argue that merely being a member of the outgroup is sufficient to induce a negative bias. However, it remains unclear whether the specific nature of the outgroup matters. This issue was investigated among 7-8 and 11-12-year-old Iranian children ($N = 71$). We tested whether children are equally biased against different outgroups or if feelings toward outgroup members are driven by (a) their perceived similarity to the ingroup (Similarity Hypothesis), (b) social and political relations between the ingroup and outgroups (Intergroup Relations Hypothesis) or (c) the relative social status of the ingroup and outgroups (Social Status Hypothesis). We explored these hypotheses by assessing children's desire to affiliate with members of different social groups and whether these desires extend to other social judgments, including whether group members are perceived as trustworthy and worthy of loyalty.

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Participants evaluated ingroup members and three different outgroups: Iranian children from another school, Arab children, and children from the United States. Children's evaluations closely aligned with the predictions of the Social Status Hypothesis, with Americans ranked as the highest social status group and evaluated as positively as ingroup members, while Arabs were ranked as the lowest social status group and evaluated the most negatively. These patterns were evident on measures of affiliation, trust, and loyalty. These findings, which provide some of the first insights into the social cognition of Iranian children, point to the role that social status can play in the formation of intergroup attitudes.

O2.4 Pragmatic reasoning leads children to draw inferences about unmentioned categories from generic language

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Adults frequently use generic language to communicate information about social groups to children (e.g., "boys play sports"). Generics make explicit claims about the nature of kinds (e.g., that boys generally play sports; Carlson, 1977), but may also implicitly convey information about other unmentioned groups (e.g., that girls do not play sports). While previous research speaks to how children interpret information explicitly conveyed by generics (e.g., Cimpian & Markman, 2009; Rhodes, Leslie, Bianchi, & Chalik, 2017), little is known about whether generic language leads to these kinds of implicit inferences about unmentioned categories. Studies 1 and 2 tested whether and at what age children draw inferences about unmentioned categories from generic claims. In Study 3, we tested whether pragmatic reasoning (i.e., using social context to evaluate the speaker's intended meaning) serves as a mechanism underlying these inferences. We preregistered our hypotheses, procedures, and analyses on OSF. In Study 1, we introduced children ages 4 to 6 ($N = 236$) to a novel social dichotomy between zarpies and gorps (marked by clothing color). Across 4 trials, participants heard either generic (e.g., "zarpies are good at climbing trees") or specific statements (e.g., "this zarpie is good at climbing trees"). Participants then rated whether 2 additional individuals (one zarpie and one gorp) were also good at climbing trees. We found that across all ages, children who heard generic statements generally responded that other zarpies were good at climbing trees but that gorps were not (across 64% of trials). However, children who heard specific statements did not share this intuition, responding in this pattern across only 38% of trials (GEE binomial model: Language: $\chi^2(1) = 27.98$, $p < .001$). The tendency to draw this inference from generics began to emerge in our youngest participants (4s: generic 50% vs. specific 32%; $p = .007$) and increased with age (see Figure 1a; Language x Age (continuous): $\chi^2(1) = 4.05$, $p = .04$). In Study 2 ($N = 60$ 4- to 6-year-olds), we replicated these findings using a truncated introduction to the novel social dichotomy between zarpies and gorps (Language: $\chi^2(1) = 37.2$, $p < .001$), suggesting that the tendency to make inferences about unmentioned groups from generics is present even for groups that children know relatively little about. In an ongoing Study 3 ($N = 108$ 4- to 7-year-olds), we examined whether pragmatic reasoning underlies these inferences about unmentioned groups. To test this, we manipulated the informativeness of the generics that children heard (i.e. whether the speaker was knowledgeable or not). Preliminary findings (see Figure 1b) suggest children make these inferences when the generic was said by a knowledgeable speaker (53.8% of trials) but do so less when said by an unknowledgeable speaker (30.9% of trials; Condition: $\chi^2(1) = 14.16$, $p < .001$). The tendency to make

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these inferences from knowledgeable but not unknowledgeable speakers increases with age (Condition x Age (continuous): $\chi^2(1) = 6.62$, $p = .01$). Together, these studies provide evidence that a) children infer implied meanings from generics that go beyond what was explicitly stated and that b) children's pragmatic reasoning serves as a mechanism by which children make these inferences. We will conclude by discussing the role that generic language may play in inadvertently communicating social stereotypes to young children.

O2.5 Learning about the social world through pragmatic inference

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Children readily learn information about the social world from language. For example, hearing generic language about a social group--e.g., "Boys are good at math"--leads children to essentialize it and form stereotypes about its members (Gelman & Roberts, 2017; Rhodes, Leslie, & Tworek, 2012). However, information about social groups can also be communicated in more indirect ways that go beyond literal sentence meanings (Grice, 1975). If a teacher has just observed a classroom of boys and girls and says "The boys are good at math," they may express that the girls are worse than the boys at math, because they could have instead said "The boys and the girls are good at math". Such inferences critically depend on the situational context: no inference about the girls would arise if the teacher had only observed a classroom of boys before making their statement. Recent research suggests that, although preschoolers struggle to make scalar implicatures (e.g., Huang & Snedeker, 2009), they readily make pragmatic inferences when they are supported by the context (Stiller, Goodman, & Frank, 2015), and that this provides a mechanism for learning more about the world (Horowitz & Frank, 2016). Here, we apply these ideas to explore whether children can learn about the social world from what a speaker could have said--but chose not to say--about a social group. We introduced 46 3-5 year-olds and 102 adults (data collection ongoing) to two novel alien groups on a faraway planet, Stripeys and Dotties. Participants heard a story about an astronaut who learned about the planet from a resident scientist, and made claims about how good the aliens were at different activities. For example, the astronaut stated that "the Stripeys are pretty good at building chairs", and the participants were asked to rate how good they thought the Dotties' chairs are (unmentioned alien), how good the Stripeys' chairs are (mentioned alien), who makes better chairs, and rate their certainty. Our critical manipulation concerned the context preceding the astronaut's claim. In the broad context, the astronaut made the claim after having looked at folders containing pictures of objects made by both Stripeys and Dotties. In contrast, in the narrow context, the astronaut had looked only at the folder with pictures made by the mentioned alien type. We expected that in the broad context, participants would be more likely to make an inference that the mentioned aliens are more skilled at the target activity than the non-mentioned aliens, compared to in the narrow context. This is because in the broad context there is a salient, more inclusive alternative utterance--e.g., "The aliens are good at building chairs"--making the astronaut's choice to exclude one alien group informative. Our results confirm this prediction: children showed this pattern in their ratings of the objects built by the mentioned vs. unmentioned aliens, and, less reliably, in forced choice judgments ("who's better at making chairs?"), but not in certainty ratings; adults showed this pattern across choices and certainty ratings. These findings suggest that even preschoolers

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are capable of learning about the social world by "reading between the lines", perhaps drawing stronger inferences than adults.

Oral Papers III

O3.1 Semantic transferability rather than perceptual sparseness may underlie the advantage of simple objects in young children's relational transfer

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Preschool children are able to generalize relational structures (e.g., spatial relation, and mathematical relations) from a single instance to another instance, but their ability is significantly influenced by the type of objects used to depict the relations. Prior work has shown that children better transfer spatial relations (ON, IN, and above) when shown a sample consisting of abstract geometric shapes than realistic objects (Park & Casasola, 2017). In the present study, we aimed to better understand the advantage of abstract geometric shapes by exploring exactly where the advantage comes from. Specifically, we focused on two characteristics of abstract geometric shapes. First, they are perceptually sparse in that they have less surface features (colors, patterns, and parts). Second, they are semantically transferable in that they are more flexible in terms of their referents. For example, a realistic table can refer to tables only; it can't refer to a door. In contrast, a drawing of a rectangle can refer to many things such as a door, a table, and a piece of paper. We asked which characteristic of these is responsible for the advantageous effect of geometric shapes. Four- to six-year-old children (N = 160) in Korea were tested with a modified spatial analogies task, in which children were asked to transfer the spatial relations of on, in, and above from a single sample to one of three options. Children were randomly assigned to one of the three conditions: (1) Plain Geometric Shapes, (2) Decorated Geometric Shapes, and (3) Realistic Objects conditions. In the Plain Geometric Shapes condition, the objects in the samples were black-and-white line drawings of geometric shapes, which were not only perceptually sparse but also semantically highly transferable. In the Decorated Geometric Shapes condition, the objects in the sample were geometric shapes that were decorated with multiple colors and patterns, thus perceptually rich but semantically highly transferable. Lastly, the Realistic Objects condition presented the sample consisting of objects that were perceptually rich and semantically less transferable. If the advantage of abstract geometric shapes stems from their perceptual simplicity, then perceptually rich geometric shapes would not be advantageous, failing to promote young children's transfer of spatial relations. If the advantage stems from semantic transferability of geometric shapes, then even perceptually rich geometric shapes would be advantageous as the perceptually sparse shapes. We found lower level of transfer performance in the Realistic Objects condition than in the Decorated shapes condition. In addition, there was no difference in children's transfer performance between the Decorated and Plain Geometric Shapes conditions. Thus, the results suggest that semantic transferability but not perceptual sparseness of abstract geometric shapes may be mainly responsible for the advantage of abstract geometric shapes in promoting children's relational transfer.

O3.2 Gestures facilitate word learning in shared storybook reading

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Shared storybook reading is one of the most common everyday activities children experience in western societies and it is an important context in which children learn words. From the young word learners' perspective, to learn the correct word-referent mappings from books, they need to link what they see with what they hear. However, given multiple objects on a book page, it is not clear how young learners direct their attention to the right referent when hearing a to-be-learned word named by parents. The aim of the current study is to examine how correct word-object mappings may be established through gestures generated by both social partners during book reading. We hypothesize that young learners most often do not attend to the objects named by parents without additional social cues. However, their abilities to use their own gestures to direct the other social partner's attention and to follow the other's gestures to redirect their own attention could be critical for early word learning. Method. Sixteen parent-child dyads participated (Mage = 19.03 m.o.). As shown in Figure 1, parents and toddlers sat next to each other at a table. They were provided with 5 storybooks and parents were instructed to read naturally to their children for 15 minutes. We used a dual eye-tracking paradigm to record moment-by-moment parents' and children's eye gaze. In total, we collected 45 book reading sessions, providing 2.5 hours of video footage for coding and analyses. 1. Speech and Gesture: On average parents produced 17 utterances per min and each utterance was about 2-second long. Parents on average gestured 9.52 times/minute and children gestured 3.43 times/minute. 2. Coupling of naming and gesture: We then examined the coupling of naming and gesture to see how they are temporally aligned. We found that gestures (either from parents or toddlers) were highly coupled with parents' naming. About 74% of the naming moments were associated with gestures. Parents gestured (56%) more with naming compare to children (18%). There were also more matched gestures (point at the named object, 56%) than mismatched gestures (18%). 3. Effect of gesture on attention during naming: By investigating the effect of gesture on attention, we found that there were different types of learning situations in book reading contexts. Without gestures, 60% of the time, the child never looked at the target object. But in cases with parent matched gestures, the referential ambiguity was significantly reduced, meaning that there were much fewer instances (45%) that the child never looked at the target. We also found an increase of target look compare to no gesture and mismatched gesture cases. We observed a very similar pattern in cases with child gestures. Gestures created by toddlers themselves can also reduce referential ambiguous by driving their own attention to the correct target. Our findings show that given that there are many objects on a book page, children do not necessarily look at the objects named by the parents. Although individual naming instance can be highly ambiguous or even misleading, gesture cues from both parents and children can significantly reduce the degree of referential uncertainty and provide more informative data for young learners. In other words, gestures from both parents and children are critical for building correct word-object mappings in shared storybook reading context.

O3.3 Disrupting development: The influence of maternal depression on parent-child interaction and child expressive language

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Parent-child interactions play a major role in the language learning environment during infancy and early childhood. An important aspect of high-quality interaction is fluency and connectedness, or the balance and flow of conversation between the caregiver and child (Hirsh-Pasek et al., 2015). Maternal depression can negatively impact both child language development and caregiver behaviors (Stein et al., 2008), however little research has examined how maternal depression affects fluency and connectedness, and hence, child language outcomes, or whether these associations differ across socioeconomic strata. Here, we examine the relations between maternal depression, fluency and connectedness, and expressive language in a low- and high-income sample, hypothesizing that maternal depression will relate to the fluency and connectedness of the interaction and children's subsequent language scores. Furthermore, we predict that socioeconomic status will moderate these relations. 120 mother-infant dyads were selected from a community sample (NICHD Study of Early Child Care and Youth Development). Families were categorized into income groups based on their income-to-needs ratio at 24 months. 60 participants were selected from each income group for this study. One participant was excluded due to missing data ($n=119$). Maternal depressive symptoms were assessed at 6-months using the Center for Epidemiologic Studies Depression (CES-D) scale, parent-child interaction at 24-months was assessed using fluency and connectedness (FCC; Adamson et al., 2016), and expressive language was assessed at 36-months using the Reynell Developmental Language Scales (Reynell 1991). The FCC of the interaction was rated on a 1 to 7 scale, with high levels of FCC indicating a more balanced and dynamic conversation, whereas lower levels of FCC indicate the conversation was dominated by one partner, or the dyad were not engaged with one another. Across income groups, higher levels of maternal depressive symptoms at 6-months were related to poorer child expressive language at 36-months ($\beta=-0.312$, $SE=0.164$, CI , -0.0730 , -0.079). For low-income families, the relation between maternal depressive symptoms and child's expressive language was accounted for by FCC at 24-months ($\beta=-0.208$, $SE=0.092$, $CI=-0.429$, -0.055), but for high-income families, it was not ($\beta=0.053$, $SE=0.120$, $CI=-0.115$, 0.371). These results suggest that children of mothers experiencing depressive symptoms, especially in low-income families, are at-risk for developing poorer language skills due in part to poorer-quality interactions. Parent-child interactions lay a foundation for language development, but this foundation is disrupted when mothers experience depressive symptoms, especially in low-income families. Higher-income families may have access to protective factors unavailable to their lower-income counterparts. Acute bouts of depressive symptoms may relate to parent-child interactions differently than chronic symptoms and clinical levels of depression may relate differently than subclinical levels. Therefore, in future analyses we will examine the trajectory of depressive symptomatology as well as clinical thresholds to further elucidate the relation between maternal depression, parent-child interactions, and child language outcomes. Altogether, these results highlight how environmental risk factors relate within diverse environments to contribute to children's cognitive development.

O3.4 What is a good question-asker better at? From unsystematic generalization, to overgeneralization, to adult-like selectivity across childhood

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Prior research showed that young children are selective social learners and take into account others' knowledge and expertise to decide from whom to learn. Recent research suggests that young children are also sensitive to the process by which others have acquired knowledge and prefer to seek help from actors who have demonstrated active learning competence. What inferences do children make based on the ability to search effectively, for example by asking informative questions? Are good question-askers smarter, more knowledgeable, or better at solving problems? Do adults make similar inferences and generalizations? In this project we explored across three experiments to what extent adults and children generalize the ability to ask informative questions to more or less-related abilities or characteristics. In Study 1 (adults, $N = 30$) and 2 (3- to 9-year-olds, $N = 120$), we presented participants with a storybook depicting two monsters: one monster always asked informative questions and the other always asked redundant, uninformative questions. Participants were then asked to choose which monster they thought was most likely to possess/was better at 12 different characteristics/abilities. Our results show a clear developmental trend: Three- and 4-year-olds drew unsystematic inferences from the monsters' question-asking expertise, showing no preference for the good question asker when evaluating abilities, traits and characteristics that both adults and older children deemed strongly related to question asking (e.g., being good at treasure hunting). At the same time, they showed a strong preference for the good question asker on some clearly irrelevant questions (e.g., having siblings). Five- and 6-year-olds identified the good question asker as more likely to have nearly every presented ability/characteristic. Seven- to 9-year-olds showed adult-like response patterns, selectively associating question-asking competency to some, relevant abilities and characteristics (e.g., being good at school, being clever), but not to others (e.g., kicking a ball further, liking ice cream). In Study 3 we disentangled the inferences that 5- to 9-year-old children ($N = 59$) and adults ($N = 20$) draw based on an agent's strategic competence versus epistemic knowledge. We presented participants with two agents: Yellow was an expert in a specific domain (i.e., fish), but was not good at asking questions; Blue was good at finding out things by asking questions, but did not know anything about fish. During the test phase, participants had to ask one of the two agents for help to answer three questions: one targeting the domain of expertise of Yellow (fish), one targeting a similar domain (animals) and one targeting an unrelated domain (houses). Preliminary results show again a clear developmental trend: Older children (7- to 9-year-olds) and adults were selective when asking for help, showing a preference for the good question asker on the similar and unrelated domain, but selected the fish expert when the question was about fish. Younger children (5- to 6-year-olds) were equally likely to ask the two agents for help on the similar and unrelated domains, although they already preferred the fish expert when the question was about fish. This project is a first step in understanding whether and how children use their sensitivity to others' active learning competence to navigate the social world, identifying good role models to learn and to learn how to learn from.

O3.5 Automaticity of reading continues to develop into adulthood

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Research on cognitive development has largely focused on childhood - especially early childhood - for good reason: that is when the bulk of learning and development happens. However, it has long been

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known that at least some cognitive abilities continue to be refined well into adulthood. For instance, people's vocabularies show substantial continued growth well into sixth decade of life (Hartshorne & Germine, 2015). Grammar - often thought of as being largely acquired by kindergarten - also shows continued improvement until about 30 years of age (Hartshorne, Tenenbaum, & Pinker, 2018). Not only do people continue to acquire knowledge, the ability to learn may itself change in adulthood. For instance, the ability to learn new faces peaks at around 30 years old (Germine, Duchaine, & Nakayama, 2011). Just how much this long unfolding of learning and development should affect cognitive development theory is unclear. Until recently, it was widely believed that lifespan development was well-characterized by a clear dichotomy between fluid intelligence, which involves flexible thinking and peaks by late adolescence, and crystallized intelligence, which involves marshalling accumulated knowledge and peaks in late adulthood (Salthouse, 2003). However, researchers are increasingly finding cognitive abilities that do not fit either of these developmental trajectories (Hartshorne & Germine, 2015), and indeed even the fluid/crystallized dichotomy itself has come under question (Hampshire, Highfield, Parkin, & Owen, 2012). We present additional evidence from the automaticity of reading. 10,647 native English speakers completed a modified Stroop task and a flanker task. The subjects were volunteers who were recruited online using a well-established platform that has been extensively validated [citation suppressed for anonymity]. In the modified Stroop task, subjects saw the words ORANGE or WHITE on a computer screen with orange or white lettering. They were instructed to press 'o' or 'w' on the keyboard to indicate whether the font color was orange or white, respectively. The task consisted of 14 congruent trials (the font color matched the word) and 14 incongruent trials (the font color and word mismatched). In the analogous flanker task, subjects identified the direction of the central arrow in displays like >><> and >>>>. Analysis focused on ages for which there were at least 10 subjects, resulting in the exclusion of 109 subjects younger than 10 or older than 77. Interference was measured as the log-transformed reaction time for congruent trials minus incongruent trials: negative numbers indicate greater interference. Stroop interference increased across the lifespan, with a slight plateau between 30 and 50 (Figure). The increased interference from 10-40 cannot be attributed to attentional control per se: flanker interference decreased during childhood and did not begin to increase again until 40 (Figure). This qualitative description was confirmed using optimal break-point estimation (see Hartshorne et al., 2018). Thus, increased Stroop interference through 40 is likely due to learning. The Stroop results contrast with some prior, smaller studies (Comalli, Wapner, & Werner, 1962; Schiller, 1966). We discuss possible explanations due to sample size, statistical analysis, and method. We also discuss these findings in the context of theories of learning and development.

Oral Papers IV

O4.1 Developing a measure of young children's self-perceptions of cognitive control skills.

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Cognitive control skills in early life are vital to success throughout the lifespan. Such skills have been positively linked to a host of important short- and long-term outcomes across many diverse domains (e.g., Moffitt et al., 2011; Schmidt, Pratt, & McClelland, 2014; Son, Lee, & Sung, 2013). Similarly, self-perceptions such as self-efficacy, implicit beliefs about cognition, and self-concept have all been shown to predict meaningful variance in important outcomes like academic performance, even when

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controlling for direct measures of cognitive ability (e.g., Bong & Skaalvik, 2013; Dweck & Leggett, 1988; Lyons & Ghetti, 2011; Lyons & Ghetti, 2013). To what extent do young children have a self-perception of their own level of cognitive control functioning? To date, no measures have been developed to assess young children's perceptions of their own skills in this regard. In the current study, we aimed to develop and validate a scale capturing children's self-perceptions of their cognitive control skills via a puppet interview (Ablow & Measelle, 1993). 125 children aged 4- through 7-years participated in an interview in which two identical puppets, voiced by the experimenter, each presented a contrasting pole on a series of 26 self-perception scale items and then asked participants to indicate which one they most identified with. Participants were free to respond in a number of developmentally appropriate ways to indicate their endorsement and responses were translated by trained coders into a 7-point Likert scale. Participants also completed a battery of lab-based behavioral measures and self-reports of other self-perception constructs. As well, parents completed a battery of parent-report measures of their child's self-regulatory functioning. Scale analyses of these interviews suggest the scale elicits responses that cluster around two correlated, but separable components: 1) Self- and Emotion-Regulation, and 2) Attention Modulation. Responses on these two subscales showed moderate to strong internal consistency, were strongly correlated with parent reports of similar skills, and self-reports of related constructs, but showed no systematic relation to behavioral tasks measuring executive functioning abilities. The findings suggest that young children are capable of reflecting and reporting coherently on their own cognitive control skills, and that these children's responses to the new scale's items correspond to parent reports of similar abilities. Further scale refinement and targeted validation efforts are needed; however, these encouraging early results suggest the new scale holds potential to uncover how children's self-perceptions influence their learning success.

O4.2 Flexible attention to numerical and spatial magnitudes and children's development of math skills in preschool

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The Flexible Attention to Magnitudes (FAM) account proposed here argues that a fundamental challenge young children face in early math--that is not addressed by current interventions--is disentangling numerical and spatial dimensions of magnitude and making decisions about which dimensions are relevant in solving certain early math problems. Previous studies showed that children have difficulty making numerical magnitude judgments in cases where numerical magnitudes (discrete and countable objects) and spatial magnitudes (continuous dimensions such as surface area) are incongruent - for example, determining which box has more rocks when one box has ten small rocks and another has two large rocks. We argue that FAM ability is a key predictor of overall math ability, including tasks that require the flexible attention to both spatial and numerical dimensions of magnitude (e.g., number line estimation). Children's FAM ability is also proposed to be related to children's executive functioning skills, as children must learn when to inhibit attention to irrelevant dimensions of magnitude and when to shift between them. We hypothesized that children's FAM ability would be significantly associated with children's growth in math skills across the preschool year, controlling for executive functioning skills, language, and other covariates (age, gender, family income). Preschool-aged

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children (N = 213; 53.1% female; Mage = 54.2 months; 47.4% of families had incomes below \$25,000) were recruited in the fall of their preschool year and were assessed in both the fall and spring on a battery of measures, including a newly developed measure of FAM ability, executive functioning skills (Minnesota Executive Function Scale), math achievement (Woodcock-Johnson Tests of Early Cognitive and Academic Development Number Sense Scale), and language (Woodcock-Johnson Tests of Early Cognitive and Academic Development Picture Vocabulary Scale). In the FAM ability task, children were first asked to choose which of two boxes contained bigger stars (6 trials), then they were asked to switch rules and choose which of two boxes contained more stars (6 trials), and finally, they were asked to shift between choosing which of two boxes contained bigger and which of two boxes contained more stars (12 trials). Trials were all incongruent with respect to spatial and numerical magnitudes such that the box containing more stars always had smaller stars, while the box containing bigger stars always had fewer stars. Children were not prevented from counting on the task, and the number of stars in each box ranged from 1 - 10. Results indicated that children's FAM ability in the fall was a significant predictor of their spring math achievement ($B = .17, p = .019$), controlling for fall math achievement, executive functioning skills, language skills, and other covariates. Results will be discussed in terms of plans to improve the FAM ability measure and potential strategies for testing the malleability of FAM ability in common early childhood math tasks.

O4.3 The neural basis of selective and flexible dimensional attention

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Between the ages of 3 and 5, children develop greater control over the allocation of attention to visual dimensions. For example, children develop the ability to flexibly shift attention between visual dimensions and to selectively process information within a visual dimensions of an object. Previous proposals have suggested that selective and flexible attention are developmentally related to one another; however, the relationship between flexibility and selectivity has not been systematically probed at the behavioral and neural levels. Previously, we developed a dynamic neural field model to explain behavioral and neural on the development of flexible attention in the context of the dimensional change card sort task (DCCS; see Figure 1a). The DCCS requires children to switch from sorting cards by shape or color to sorting cards by the other dimension. Typically, the majority of 3-year-olds fail to switch rules in the task but the majority of 4-year-olds can switch. The model operates based on neural activation dynamics within populations of simulated neural units that are tuned to dimensions of perception and action. The model is composed of an object representation system that binds visual features such as shape and color to spatial locations and a label learning system that associates labels such as "color" or "shape" with visual features. Performance in the DCCS task relies upon the quality of associations between labels and visual features: with weak associations the model perseverates on the habits accumulated during the initial sorting phase, but with strong associations the model switches rules. Thus, with stronger associations between labels and visual features, the model can flexibly shift attention between dimensions. We have previously demonstrated that this model explains both behavioral and neural data on the development of performance in the DCCS task (Buss & Spencer, 2014; 2018). In this report, we generalize this model to also explain development of attentional selectivity.

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Specifically, we generated behavioral and neural predictions on the association between performance on the DCCS task and a task that requires selective attention, the triad classification (TC) task (Smith & Kemler, 1977; see Figure 1a). The TC requires children to selectively attend to a single dimension to pick matching objects. Whereas the DCCS requires explicit attention, the TC task requires implicit attention and determining which dimension is relevant based on the configuration of stimuli. We tested model predictions by administering the DCCS and TC tasks to 3.5- and 4.5-year-olds while functional near-infrared spectroscopy data were recorded from bilateral frontal cortex. Results supported model predictions. First, children who demonstrated flexibility in the DCCS task also demonstrated higher levels of selectivity in the TC task (see Figure 1b). Second, performing well on either task was associated with increased activation in right frontal cortex as indexed by changes in HbO (see Figure 1c). These results suggest that dimensional attention development is a common process that drives developmental changes across tasks that require the controlled allocation of attention to visual dimensions across differing task demands. Moreover, development in right lateral frontal cortex is responsible for the development of dimensional attention, which we propose is involved in the formation of representations that bind visual features to auditory labels.

O4.4 Children don't really think about rational numbers as being equivalent in size

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The importance of fractions for math outcomes (Siegler et al., 2012) and evidence supporting a theory of numerical development that integrates all rational numbers (Siegler, Thompson, Schneider, 2011) has been documented, but little is known about the relations among notations. This is troubling because understanding involves incorporation of concepts into an internal network, whereby the degree of understanding is determined by the strength and accuracy of connections between related concepts (Hiebert & Carpenter, 1992). Therefore, fluid understanding of the connections among fractions, decimals, and percentages indicates deeper understanding and superior performance (Moss & Case, 1999). While there's some information about comparison across fractions and decimals (e.g. Hurst & Cordes, 2016), much less is known about comparison across all notations including percentages. Before debating which notation is best to learn first (Tian & Siegler, 2017), we must first understand how children conceptualize the relation among all notations. Thus, we tested middle school children (N=70) to explore how they perform on magnitude comparisons across all three notations; half of the items compared values with identical or nearly identical digits (e.g. compare $\frac{4}{5}$ versus 45%) and half were matched for magnitude across all notations with small, medium, and large differences between compared values (e.g. compare .40 versus 25%, $\frac{2}{5}$ versus .25, .4 versus $\frac{1}{4}$, etc.). Results showed that children do not actually think about equivalent rational numbers as being equivalent; instead our findings showed that students have a bias towards perceiving percentages as larger than fractions/decimals and fractions as larger than decimals. Accuracy was 92.3% for items where the percentage was larger than fraction/decimal, as compared to 60.7% accurate for items where the percentage was smaller than fraction/decimal. Similarly, overall accuracy was 82% for items where the fraction was larger than the decimal, as compared to 54% accurate for items where the fraction was smaller. Evidence for the bias is reflected in statistically significant differences between mean scores for

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items where Percent>Fraction and Fraction>Percent ($p<.001$, $t(69)=7.069$), Percent>Decimal and Decimal>Percent ($p<.001$, $t(69)=6.538$), and Fraction>Decimal and Decimal>Fraction ($p<.001$, $t(69)=6.452$). After number line instruction with all notations, this percentage is greater than fraction/decimal bias persisted, though it weakened somewhat. Accuracy was 80% for Percent>Fraction as compared to 70.7% accurate for Fraction>Percent ($p=.02$, $t(69)=2.346$) and 95% accurate for Percent>Decimal as compared to 76% accurate for Decimal>Percent ($p<.001$, $t(69)=5.187$). The instruction was fruitful in reducing the fraction is greater than decimal bias, as there was no difference in performance when the fraction was larger or smaller than the decimal at posttest ($p=.874$, $t(69)=.159$). We are currently testing the replicability of this finding in another sample, but the fact that post-test results following targeted number line instruction demonstrate greater accuracy when the percentage was larger suggests that the percentage is greater than fraction/decimal bias is real. Finally, to our knowledge, this study is the first to examine magnitude comparisons across all three rational number notations. The initial finding of a skewed perception of size warrants further research in this area.

O4.5 The dynamic nature of children's strategy use after receiving feedback in decimal comparisons

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When students start learning decimals, they may incorrectly apply features of their prior numerical knowledge (e.g., whole-number or fraction rules) when reasoning about decimals. However, since whole numbers, fractions, and decimals are fundamentally different, these whole-number and fraction strategies often lead to incorrect solutions. We examined whether receiving immediate feedback while comparing decimal pairs that are either congruent with whole-number rules (e.g., treating numbers with more digits as larger in magnitude) or fraction rules (e.g., treating numbers with fewer digits as larger in magnitude), would lead students to change their decimal-comparison strategy. We hypothesized that, given feedback on their decimal-comparison accuracy, students would reduce their use of whole-number rules, temporarily increase their use of fraction rules (i.e., try an "opposite" strategy), and ultimately increase their use of an accurate decimal-comparison strategy. We also hypothesized that improvement in decimal comparisons would transfer to decimal comparisons involving different numbers of digits. Sixth- to 8th-graders ($N=171$) were randomly assigned to an experimental or control condition. The conditions differed only in the initial training block, in which they compared 84 decimal pairs either with feedback (experimental condition) or without feedback (control condition). All training pairs included a 1-digit versus 2-digit decimal; half were congruent with the whole-number rule (e.g., 0.3 vs. 0.86) and half were incongruent (e.g., 0.8 vs. 0.34). All participants then completed a posttest without feedback, which included 28 decimal comparisons of the same format as the training block, and decimal comparisons involving different numbers of digits than the training block (e.g., 0.2 vs. 0.356 and 0.75 vs. 0.142). See <https://osf.io/fphxw> for preregistration. Consistent with our hypotheses, generalized estimating equations (GEEs) showed that in the experimental condition (with feedback), the percent of students using a whole-number rule decreased over time during the training block (Slope $B=-.12$, $SE=.03$, $p<.001$), and the percent of students showing decimal accuracy (high accuracy on congruent and incongruent pairs) increased over time (Slope $B=.10$, $SE=.02$, $p<.001$). As expected, in the control condition, the percentage of students who have whole-number bias or decimal accuracy did

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not significantly change over the training trials ($p > .360$). However, our hypothesis of a temporary increase in fraction bias during training was not supported ($p > .493$). On all posttest measures, whole-number bias was lower in the experimental than control group ($p \leq .001$), and decimal accuracy was higher in the experimental condition than the control ($p \leq .005$). Thus, students' whole-number bias in decimal comparisons was reduced after receiving feedback on decimal pairs where the whole-number rule was not applicable half of the time. Students quickly learned the correct decimal strategy without necessarily trying out the incorrect fraction strategy. Additionally, students' high accuracy on posttest decimal comparisons with different numbers of digits indicates that they did not simply learn a procedural rule but a more comprehensive understanding of decimal place value. Overall, the current study provides insights for reducing students' misconceptions in learning decimals, which could be beneficial to their long-term mathematical development.

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Poster Abstracts

Session 1

A -Perception, action, attention and cognitive control

1-A-1 The functional significance of cross-sensory correspondences in infant-directed speech

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Research suggests that prosody plays a fundamental role in the communication and resolution of ambiguous word meaning. Specifically, users of infant-directed speech are found to manipulate their prosody to reflect known cross-sensory correspondences between audition and vision (e.g. higher-pitch sounds are higher in space). But do infants attend to these prosodic cues in an attempt to resolve linguistic uncertainty? We presented 24-month-olds with novel object pairs varying by a single dimension (e.g. brightness, height, size, sharpness, thinness or weight) and asked them to match one object to a novel word (e.g. "Where is the rebo one?"), spoken in either a high/low-pitch tone of voice and fast/slow rate of speech. Infants paired novel words spoken in a higher- or lower-pitch and faster or slower rate with objects positioned higher or lower in space, respectively. These findings suggest that, for pitch-height correspondences only, infants attend to prosodic cues to interpret novel words.

1-A-2 Development and validation of a creative thinking task for young children

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Creativity has been identified as a critical skill that should be fostered by educators. However, promotion of creativity depends on valid measurement of children's creativity. This poster discusses the development of a new creative thinking task for children, the Teddy Bear Task. In this task, children are presented with a scenario involving a boy, Alex, who must retrieve his teddy bear from an out-of-reach shelf. Children complete two versions of the task: One with no props, and one in which a standard set of props (e.g., blocks, toy broom), which vary in the ways they could be used to retrieve the bear, is provided. Method: 77 children (49% female, M age = 5.95, SD = 1.20, range = 4.06 - 7.99 years) participated. Children's race and ethnic heritage varied but the majority were white. Children were interviewed individually and completed both versions of the Teddy Bear Task, an Alternate Uses task, and an Imagination interview. Results and Discussion: Creativity scores calculated from the two versions of the Teddy Bear Task correlated significantly with scores from the Alternate uses task ($r_s = .28$ to $.62$, all $p < .05$), supporting the convergent validity of the task. Teddy Bear Task scores were not significantly correlated with imagination scores, indicating discriminant validity. Together these results indicate that the Teddy Bear Task is a valid measure of creativity.

1-A-3 Can people change? Expectation of change and implicit theories of intelligence among Chinese and American children

Liao Cheng¹, Paul Harris¹

¹Harvard University

Adults from Western cultures tend to believe that personal characteristics (such as intelligence and personality) are stable, whereas adults from East Asian cultures tend to believe that personal characteristics are malleable (Lockhart, Nakashima, Inagaki, & Keil, 2008; Nisbett, Peng, Choi, &

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Norenzayan, 2001). Previous research has generated mixed findings regarding the age at which these cultural differences emerge: while some suggested that they do not emerge until the age of 8 or 9 (Ji, 2008; Lockhart et al., 2008), some reported differences among 3- to 5-year-olds (Kuwabara, Son, & Smith, 2011). This study examines beliefs about the stability versus malleability of personal characteristics among 4- to 9-year-olds in the U.S. and China. Children were asked to predict whether story protagonists would change or stay the same in the future. They also responded to hypothetical scenarios which assessed their implicit theories of intelligence (i.e., beliefs about the malleability of intelligence). Consistent with previous research (Ji, 2008; Lockhart et al., 2008), the findings revealed an optimistic orientation in children from both cultures: they were more likely to predict change in the positive direction than in the neutral or negative direction. They also reported strong beliefs in the malleability of personal characteristics, consistent with incremental theories of intelligence. Factors including culture and parental beliefs are discussed.

1-A-4 Environmental risk factors related to MSDP and their impact on inhibitory control in adolescence

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Maternal smoking during pregnancy (MSDP) is associated with adverse outcomes in children including low birth weight, atypical neurodevelopment, poorer academic achievement, and a spectrum of behavioral problems. Increased exposure to MSDP is also linked to greater deficits in cognitive functioning in adolescence. Children exposed to MSDP exhibit less efficient executive function (EF) abilities than non-exposed children, including poorer inhibitory control (IC). Because studies of the effects of MSDP on child outcomes are confounded by co-occurring genetic and environmental risks, the causal pathway linking MSDP to IC problems is unclear. We applied a sibling comparison framework to evaluate within-family (i.e., potentially causal) effects of MSDP and co-occurring risk factors (i.e. shared and nonshared genetic and environmental factors) on IC. IC scores, assessed with the Logan stop-signal task, are evaluated based on the reaction time to a stimulus by either withholding their response (i.e., stop-signal) or actively responding (i.e., go-signal). MSDP was not associated with IC ($b = 0.002$, $SE = 0.004$, $p = 0.74$). Mother's age ($b = -0.03$, $SE = 0.01$, $p < 0.01$) and birth order ($b = 0.09$, $SE = 0.03$, $p = 0.014$) were associated with IC, suggesting that being born first and a mother's youth may be protective factors against IC problems. These results are consistent with a broad range of literature, which suggests the mother's inability to quit smoking during pregnancy is associated with comorbid risk factors related to socioeconomic status. Further research is needed to isolate the predictors of IC problems earlier in development to determine potential targets for intervention.

1-A-5 Measuring exploration and exploitation across development

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The interplay between the decision-making processes of exploration (gathering new information, potentially at the expense of immediate reward) and exploitation (taking advantage of known information to obtain reward), has long been of interest among cognitive scientists. Interestingly, while a substantial number of laboratory tasks purport to measure exploration/exploitation, it remains unclear if these tasks measure a single unified construct. Furthermore, few studies have examined developmental changes in exploration/exploitation. In this study, we examined 1) changes in the

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dimensionality of exploration/exploitation across development, 2) age-related changes in overall tendencies to explore or exploit, and 3) age-related changes in exploration strategies. We tested 122 individuals representing ages 4-5 years, 10-12 years, and 18-25 years, who completed a chain and/or grid task (Dale, 2018) and a patch foraging task (Lenow et al., 2017). In all tasks, participants could choose to either explore or exploit on each trial. The patch foraging task included short and long travel time conditions, representing varying "costs" associated with exploration. Principal components analyses revealed that behavior on these tasks converged on one factor in preschoolers, but loaded on two different factors (chain/grid on Factor 1 and patch foraging on Factor 2) in youth and adults, suggesting that processes underlying exploration/exploitation become differentiated over time. In terms of overall tendencies to explore or exploit, there was a main effect of age on exploration during the patch foraging task, $F(2) = 16.58$, $p < .001$, indicating that young adolescents explored the most, young adults explored at an intermediate level, and preschoolers explored the least. In addition, young adolescents explored more than adults in the grid task, $F(1) = 4.02$, $p < .05$. Furthermore, an interaction between age and travel time in the patch foraging task, $F(2, 120) = 3.25$, $p < .05$, indicated that only young adults factored travel time into their decisions to explore or exploit. In all, these results suggest that 1) by early adolescence, exploration/exploitation may encompass several cognitive processes that are reflected differentially across a variety of tasks; 2) early adolescence may be a developmental period characterized by higher exploration than early childhood or young adulthood; and 3) young adults integrate contextual factors into their decision-making to explore more strategically than adolescents. Taken together, these data suggest that these decision-making processes are operating differently at various stages of development, and also that tasks purportedly measuring these mechanisms may each be tapping slightly different processes. These differences might reflect varying degrees of uncertainty about the environment and/or differing cognitive flexibility demands.

1-A-6 Investigating infants' looking behaviours towards motion trajectories: The role of manner and direction

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Previous research suggests that infants' looking behaviours towards different types of motion are dependent on the specific characteristics of the stimuli presented. Known contributing factors include rate of motion, trajectory orientation (e.g., vertical vs. horizontal), and development of oculomotor control. As infants' looking behaviours are sensitive to a variety of perceptual and developmental factors, a prior assessment of suitability should be considered when motion stimuli are to be presented. We report findings from one such study, testing 3-4-month-old infants ($n = 24$) and 8-12-month-old infants ($n = 24$) to establish baseline looking behaviours. Presented were animations depicting a ball varying in how it moves across the screen (manner; rounded, angular, linear) and direction (up-down, down-up, left-right, right-left). Using eye-tracking, measures included both tracking accuracy and preferential looking. The findings shed light on looking behaviours across development and inform an ongoing discussion as to whether infants have a preference for curvature.

1-A-7 Children make category generalizations based on object shape but not object color in visual recognition tasks

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Although visual recognition plays a critical role in studies of cognitive development (e.g., visual-habituation paradigms, object naming tasks) the processes that support this basic ability remain contentious in the broader literature. Research within neuropsychology has suggested that patients' ability to recognize objects that they cannot name may result from the prototypicality of target images rather than recognition processes. However, within patient populations there is the potential for disease progression to impact both recognition and knowledge systems conjointly. As a test of potential explanations, we have adapted neuropsychology tasks, in which real and chimeric objects differed by a single feature, for young children. Developmental results suggest that children's recognition is influenced by their semantic knowledge when the stimuli differed by object shape, an outcome that parallels findings in neuropsychology. However, when prototypicality was based on color, children and patients exhibited contrasting patterns. Whereas patients were again strongly sensitive to typicality, children showed no such pattern despite comparably poor performance on the task. Together these findings offer important insights and constraints for theories of how conceptual knowledge differentially informs recognition behaviors across the lifespan.

1-A-8 The effect of comprehensibility on saliency-based gaze prediction for children and adults watching Sesame Street

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Visually salient features (e.g., movement, contours) predict eye gaze during video viewing, yet this predictability increases with age (Frank et al., 2009; Mital et al., 2010; Rider et al., 2018). This age-related increase in saliency-based gaze prediction (SBGP) may be due, at least in part, to increasing comprehension of video (Kirkorian & Anderson, 2018). The current research examines the impact of comprehensibility on SBGP by comparing children's and adults' gaze patterns early versus late in a cohesive video sequence (Study 1) and while watching a random video sequence (Study 2). In Study 1, 15 four-year-olds and 16 adults watched a 4.5-minute Sesame Street segment. A computational saliency model was used to predict gaze location during each of the constituent video shots, examining effects of age and shot order (Table 1). As in previous research (Rider et al., 2018), SBGP was higher for adults than for children; however, this age difference emerged over time into the video sequence, perhaps reflecting increasing comprehension of the narrative by adults. Study 1 results suggest that moment-to-moment changes in comprehension may impact SBGP, insofar as adults' gaze becomes more predictable as the story unfolds. Study 2 will provide a more direct test of this hypothesis: 34 four-year-olds and 32 adults watched the video sequence in a cohesive or random order. SBGP analyses are in progress. We expect SBGP to be lower in children and for the random sequence.

1-A-9 Infants' inferences about insides

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When infants observe one entity in the world causing another to move, there are two types of causal information that they can track: 1) Which entity is causing the other to move in that particular event, i.e., is the "situational" agent, and 2) Whether each entity is dispositionally the kind of thing that can be a causal agent, or dispositionally inert. Previous work has found that 6-month-old infants are able to track situational agency for "launching" events, in which one object (A) moves until it is adjacent to a second, stationary object (B), at which point A stops and B begins to move in the same direction and at

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the same speed (Leslie & Keeble, 1987). However, in previous work 6-month-old infants fail to track these situational causal roles in a similar type of event called "entraining", in which, instead of stopping on contact, A moves concurrently with B, continuing in the same speed and trajectory while remaining adjacent to B the entire time (Bélanger & Desrochers, 2001). While infants are not sensitive to situational causal roles in entraining events in the same way as they are for launching events, 7-month-old infants seem to make dispositional attributions about the objects in an entraining event: If one object in the entraining event has fur and eyes and the other does not, they infer that the first object is a dispositionally animate agent (Träuble & Pauen, 2011). Here, we sought to establish whether these inferences are fully dissociated, by testing whether 10-month-old infants fail to make dispositional attributions about the objects in a launching event using stimuli and a measure with which they demonstrate dispositional attributions about entraining events. The first two experiments extended earlier work that 8-month-old infants are surprised when entities they infer to be animate agents are revealed to be hollow (Setoh, Wu, Baillargeon, & Gelman, 2013). (All stimuli and data can be found at <https://osf.io/xu4gn/>) We showed that infants make this dispositional attribution based on featural cues of animacy and an entity's causal role in an entraining event: 10-month-olds were more surprised when a self-propelling furry object ($M = 34.32$, $SD = 14.64$) was shown to be hollow compared to a human-entrained furry object ($M = 27.55$, $SD = 16.77$), $t(15) = 2.10$; $p = 0.051$; Cohen's $d = 0.53$ (see left half of supplemental figure). Experiment 3 used this same measure, and these same objects, to test whether 10-month-old infants made different dispositional attributions for the agent and patient in a launching event. Infants' looking time to the hollow agent ($M = 30.68$, $SD = 16.22$) was not significantly different from looking time to the hollow patient ($M = 28.62$, $SD = 17.23$), $t(15) = 0.51$; $p = 0.62$; Cohen's $d = 0.12$ (see right half of supplemental figure). This pattern of data suggests that 10-month-old infants did not make different dispositional attributions for objects in a launching event based on their causal role. This series of experiments suggest that, in the first year of life, infants have two different systems for representing entraining and launching events. In ongoing work, we are investigating whether these representations are integrated at a later point in development, by repeating Experiment 3 with 14-month-olds. As of this writing, 8 of the first 9 participants have looked longer when the causal agent is revealed to be hollow, but further data collection is required.

1-A-10 A machine learning platform for linking controlled rearing to artificial intelligence

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What does it mean to "understand" newborn cognition? From an engineering perspective, understanding newborn cognition requires building artificial brains that learn like newborn brains. If we truly understand how newborns learn about the world, then we should be able to mimic their learning in computational systems. To this end, we developed a machine learning platform for linking controlled-rearing studies of newborn animals to artificial intelligence. This platform allows us to raise newborn chicks and artificial agents in the same environments, and test whether they develop the same abilities when provided with the same experiences. For each controlled-rearing experiment performed in our lab, we can build a computer-simulated "virtual experiment" for measuring learning and behavior in autonomous artificial agents. The agents' brains can be equipped with different biologically-inspired learning algorithms (e.g., deep reinforcement learning, curiosity-driven learning), so by comparing the animals and agents, we can test which learning mechanisms are needed to mimic newborn cognition. In preliminary testing, we found that artificial agents can rapidly develop some domain-specific abilities

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found in newborn chicks (imprinting, object attention, object recognition; $p < .001$), even when the agent's brain contains only domain-general learning mechanisms (deep neural networks that learn through curiosity-driven exploration). Thus, domain-specific abilities can emerge rapidly from domain-general learning processes.

1-A-11 Visual processing contributions to feature search across childhood

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Visual processing improves across childhood. Here we asked whether developmental improvements in visual processing support the development of feature search, where the target is defined by a single visual feature. We tested $N = 57$, 4- to 9-year-old children on both a contrast sensitivity and feature-based visual search task, for both chromatic and luminance feature channels. We found that both chromatic and luminance contrast sensitivity improved with age ($p's < .001$), as did chromatic and luminance feature search ($p's < .001$). Moreover, better contrast sensitivity was associated with faster feature search (chromatic: $p = .06$; luminance: $p = .02$). Critically, age mediated the relationship between contrast sensitivity and feature search performance across childhood, for both chromatic (bootstrapped 95% CI [-11.78, -1.72]) and luminance (bootstrapped 95% CI [-4.42, -0.98]) feature channels. Our findings suggest that developmental improvements in visual processing support more efficient feature search.

1-A-12 Examining the roles of children's attention and parent-child interaction quality on changes in children's expressive vocabulary

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Early language abilities create a foundation for future academic success (Hoff, 2013). What factors contribute to better language outcomes? Previous research has found that longer sustained visual attention in infancy relates to higher-quality interactions with caregivers, which in turn builds a foundation for vocabulary development (McMillan et al., 2018). During the second year of life, infants' language development accelerates from speaking a handful of words to using a vast array of words to communicate with others. How might infant attention and parent-child interaction account for these gains in language skills? To address this question, we used data collected as part of a larger longitudinal study that followed children from ages 4 to 24 months ($N=49$). Mediation analyses showed a significant direct relation to sustained attention at 4 months on children's expressive vocabulary growth from 14- to 24-months such that shorter sustained attention to visual stimuli at 4 months was related to greater growth ($B = -48.53$, $SE = 21.04$, $t(45) = -2.31$, $p = .03$). All other pathways were nonsignificant (see Fig). Altogether, these findings indicate that sustained attention at 4 months, but not the quality of parent-child interactions at 14 months may account for differences in children's language development in the second year of life. Shorter durations of sustained visual attention may relate to faster processing abilities, which facilitates faster language growth.

1-A-13 A holistic approach to understanding children's emotion regulation: A longitudinal investigation of Head Start children and families

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A plethora of everyday hassles and family conflicts (e.g., children struggling with daily routines) often accompany the daily lives of low-income families, especially those living in poverty (e.g., Crnic & Low, 2002). In a recent study of children from low-income families, Kim-Spoon and colleagues (2013) demonstrated that children's emotion regulation mediated children's emotion lability/negativity and internalizing problems. However, children's emotion regulation development does not occur in a vacuum. Thus, it is important to holistically examine children's emotion regulation development by incorporating variables that assess parents (e.g., parenting strategies, parent well-being) and the family environment (e.g., conflict). The purpose of this study was to examine relations among family conflict, parenting strategies (assessed via mother involvement), parent well-being, and children's emotion regulation in a Head Start sample of 539 4-year-olds. Results revealed that child emotion regulation partially mediated mother involvement and parent well-being at the beginning (Time 1) and end (Time 2) of preschool (see Figure 1). Furthermore, family conflict was a significant direct effect on child emotion regulation. These results may have implications for understanding the roles that effective emotion regulation plays in both children's overall development as well as in the family ecology.

1-A-14 Using a memory game to enhance frontal activation in 3.5 year-olds during an executive function task

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The dimensional change card sort (DCCS) task requires children to sort cards by one dimension and then switch to sort by another dimension. Typically, 3-year-olds, but not 4-year-olds, persevere and continue using the post-switch dimension when instructed to switch. Prior exposure to the post-switch dimension in the form of a memory game facilitates performance of 3-year-olds in the post-switch phase of this task (Perone et al., 2015; 2019). In the current project, we explored the neural basis of this effect. Thirty 3.5-year-olds played either a memory game with the post-switch dimension or tic-tac-toe prior to completing the DCCS. Functional near-infrared spectroscopy was used to measure hemodynamic activity while performing the DCCS from left frontal, left temporal, and right parietal regions previously implicated in dimensional attention (Morton et al., 2010; Buss & Spencer, 2018). Data collection is still in progress, but preliminary results (see Figure 1) showed that both groups of children showed switching-related activation across all ROIs measured. Importantly, children who played the memory game before the DCCS showed increased activation in frontal cortex during the post-switch phase of the DCCS compared to children who played tic-tac-toe before the DCCS. These results support predictions of a dynamic neural field model (Buss & Spencer, 2014; Perone et al. 2015) which demonstrates how experience with perceptual dimensions can enhance activation of frontal cortex.

1-A-15 Testing the hierarchical competing systems model in young preschoolers' executive function

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The present study examined the Hierarchical Competing Systems Model (HCSM, Marcovitch & Zelazo, 2009) as a model of executive function (EF or conscious control) in young preschoolers. The HCSM suggests that EF is guided by habit related to previous experience and representation related to children's ability to represent and reflect on task relevant stimuli. 359 children (2.5 to 4.0 years) completed an age appropriate EF A-not-B task evaluating children's ability to search correctly at a new B location and resist habitual search at a previously correct A location. We varied the habit (requiring 1, 6 or 11 correct A trials before switch to B) and linguistic representational support (providing relevant linguistic labels). We found partial support for the HCSM, as more A trials related to more perseverative behavior on the first B trial. Although encouraging children to label did not improve task performance, overall language ability was related to better A-not-B performance across all labeling conditions. Interestingly, language only predicted A-not-B performance when children formed weaker habits (when they had to complete 1 A trial correctly before search at B). Results suggest the influence of habit and representation interact to predict EF behavior, as linguistic representational abilities were more important when habit was weak, potentially because a strong habit is more difficult to overcome based on emerging representational abilities at this young age.

1-A-16 Attention in action: Comparing the influence of attentional cues on behaviors across looking and touchscreen paradigms

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Tasks designed to assess attention differ across age groups, in part due to changing behavioral capabilities over development. This raises the question of whether we can draw similar inferences about attention through behaviors like eye gaze versus pointing. We addressed this question by testing 59 children aged 3-10 years in two attention tasks: the Infant Orienting With Attention (IOWA) task (Ross-Sheehy et al., 2011) and a touchscreen adaptation of IOWA, Pop the Bubbles (PtB). Respectively, these tasks measure reaction time (RT) to look versus point at a target following a visual cue (spatially valid, invalid, or dual) or an auditory cue. For some children (n=21), we also recorded gaze direction during PtB. Preliminary results (coding 90% complete) suggest that attention affects looking and pointing similarly (i.e., faster RT with valid cues; slower RT and more errors with invalid cues), but only a subset of measures correlate across tasks and PtB related to age more strongly than IOWA. We will discuss potential reasons for divergent results by considering action system constraints as well as task design, and the implications for these differences in predicting behavior beyond these tasks.

1-A-17 Kids learn what they can't ignore: Developmental differences in the processing of distractors

Marlie Tandoc¹, Bharat Nadendla¹, Chuyun Shen¹, Kay Otsubo¹, Theresa Pham¹, Amy Finn¹

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Compared to adults, children have reduced abilities to filter out distracting information. However, it remains unclear whether or not this means that children might learn more about distracting information than adults. Adults (n=60) and children (n=60; 7-9 y/o) completed an n-back task where difficulty was matched to online performance. Line-drawings of common objects (distractors) were superimposed onto n-back stimuli, but participants were told to ignore these. Participants then completed a surprise

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picture fragment completion task in which they were asked to identify--as quickly as possible--objects from fragmented drawings that progressively became more complete; half of these objects were the distractors and the other half were new. In the first half of the test we found that children, but not adults, showed evidence of priming from the distractors. In the second half of the test this finding was reversed with adults showing evidence of priming, but not children. Children's difficulty ignoring distractors therefore leads to greater knowledge of distractors, but this may only be preserved for short periods of time.

1-A-18 The relationship between the microstructure of vertical white matter pathways and behavior in early elementary school children

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A relatively unexplored group of white matter tracts has been recently described and made available for scientific investigation. These vertical white matter tracts connect ventral and dorsal cortical regions in the brain, making them distinct from the well-studied, canonical tracts that connect anterior and posterior cortical regions. We utilized multi-shell diffusion-MRI and ensemble tractography to characterize the development of vertical white matter tracts in a cross-sectional sample of 22 children (4.5-8.5 years old) and 11 adults (18-22 years old). We found that the microstructural tissue properties of vertical tracts in children were more similar to adults than the properties of horizontal tracts. The vertical tracts were more predictive of age, visual-motor skill, and literacy than horizontal tracts in the child sample. These preliminary results suggest that the development of vertical tracts may be related to learning in early elementary school.

1-A-19 Keeping track of change: developmental insights into the ability to represent events as trajectories of token-states

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Virtually every task requires the execution of specific actions on specific objects at specific points in time. We must keep track of what happens to the objects we interact with to anticipate and facilitate new changes to those objects and our world. At any moment, each object representation is flexibly bound to the history of prior events it was involved in. An object's own changes in state as well as its relationships with other objects, across time, make up its history and intersecting object histories typify events (Altmann & Ekves, 2019). While segmentation of perceptual input into events is clearly a ubiquitous cognitive process (Zacks, 2001), when and how we come to represent the contents of events-object histories- is not well understood. We investigated whether relational binding processes supporting indiscriminate associations between multiple objects within a single episode also underpin representations of change in state of an object across time. We asked 2 to 4-year-old children to choose between objects with unique histories in a novel game. We found that 2-year olds required obvious visual cues indicating a state change, but 4-year olds could discriminate between identical objects only that differed in their histories, $\chi^2(2, N=35)=7.5, p<.05$. This suggests that the ability to generate expectations about unfolding events that are constrained by the histories of the objects involved follows a protracted developmental trajectory during the early preschool years that parallels the emergence of episodic memory.

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B – Memory and reasoning

1-B-20 Meta-working memory in young children

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Visual working memory (WM) is extremely limited (Cowan, 2004). Adults are sensitive to their own visual WM limitations (i.e. Ma et al., 2017) and accordingly make decisions about when to rely on WM (Kibbe & Kowler, 2011). However, it is not known whether young children, whose WM is undergoing rapid development (Simmering, 2011), also show "meta-working memory" abilities. We examined 5- to 6-year-old children's WM and meta-WM using a novel hide-and-seek task. We hid sets of 2-5 single-feature (Study 1; N=24, mean=69.82 months) and multi-feature (Study 2; N=23, mean=72.94 months) objects, and asked children to recall the location of one of the objects. On each trial, children also were asked to gauge their confidence in their answer by placing a bet with tangible, at-risk resources. Children were not given feedback. We found that children reliably recalled the location of the probed object when 2 or 3 objects were hidden ($ps < 0.001$), with performance dropping off for set sizes 4 and 5 across both conditions. Critically, children modulated their bets based on their own accuracy; children bet higher when they were correct versus incorrect across both studies ($p < .001$; Figure 2), suggesting that children are sensitive to their own WM limitations. These data suggest that meta-WM abilities are present even as the capacity of WM is developing.

1-B-21 The effect of a delay including sleep on episodic memory interference in early childhood

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Understanding the world in general (semantic memory) requires contextualization, e.g., it is acceptable to run outside but not inside. Similarly, remembering events (episodic memory) requires links to context, e.g., pizza was served at Andrew's birthday party but hamburgers at Mason's. How do children deal with such overlapping associations? Darby and Sloutsky (2015) investigated the role of a delay including sleep on children's memory for item pairs in which one item from each pair is also related to another item. They found that 5-year-old children showed a small but significant improvement on such pairs, but not for non-overlapping pairs, after a delay including two nights of sleep. The finding suggests that sleep may help sort out a world of overlapping associations in a way that preserves their complex structure. However, Darby and Sloutsky did not examine age-related differences. Further, their procedure of memorizing static item pairs to a learning criterion likely engaged semantic memory. In the present experiment, we studied children of two ages--4 and 6 years--spanning a period of substantial improvement in episodic memory. We used a naturalistic episodic task based on Ngo et al. (2018). Children watched animated videos in which they visited several locations (e.g. a house, a park), each with two contexts (e.g. a red house and a blue house). They encounter eight pairs in each context, half of which overlap with the other context (AB-AC, e.g. pizza in the oven in the red house, muffin in the oven in the blue house), and half unique (AB-CD, e.g. pizza in the oven in the red house, milk in the fridge in the blue house). At test, children were shown an item in context, e.g., the oven in the red house, and were given a four-item forced-choice recognition test including the target (correct paired item), an across-context lure (the same-positioned item from the other context), a within-context lure (item from the same context, but not the correct paired associate), and a foil (an item never presented).

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Selection of across-context lures is particularly interesting, because this reveals the different effects of delay on relational binding depending on the degree of inference between the two associations (AB-AC vs. AB-CD). Our data ($n = 27$ 4-year-olds, 23 6-year-olds) show that children's accuracy is worse at delay than at immediate test for both types of item pairs and at both ages, after controlling for the effect of verbal intelligence (KBIT-II). Thus, we did not see delay-related improvement as in Darby and Sloutsky (2015). However, crucially, a three-way interaction for lures showed age-related change in the ability to establish contextualized links. Younger children were less likely to select these across-context lures for the overlapping item pairs after a delay than at immediate test, while older children did not show this pattern. Sleep may be central to the "sorting" of interfering associations for preschool children who are just leaving the period of daytime naps, which seems to play a role in early cognitive development (Kurdziel, Duclos & Spencer, 2013). Our results suggest a critical role for sleep in minimizing memory interference during early childhood, particularly for children under age 6.

1-B-22 Working memory capacity development: Reconciling childhood and infant findings

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There appears to be a major paradox in the developmental literature regarding the capacity of working memory, the limited information held in mind and available for cognitive processing. By 18 months or earlier, infants seem able to retain about 3 objects in working memory (e.g., Feigenson & Carey, 2005, *Cognition*; Ross-Sheehy et al., 2003, *Child Development*). Notably, this estimate is about the same as that proposed for adults when they are unable to group or rehearse the stimuli (e.g., Cowan, 2001, *Behavioral and Brain Sciences*; Zhang & Luck, 2008, *Nature*). Yet, numerous studies seem to suggest that basic working memory capacity increases from about 2 items in early childhood to about 3 or 4 items in adulthood. Here I will describe no-longer-tenable accounts of this discrepancy, and I will propose how it actually might be explained. (1) No longer tenable is a hypothesis that, because working memory depends on knowledge, younger children perform less well. There have been multiple studies in which knowledge has been equated or controlled across ages, yet age differences in capacity persist. Gilchrist et al. (2009, *Journal of Experimental Child Psychology*) presented lists of simple, spoken, unrelated sentences for verbatim recall, allowing both a measure of linguistic knowledge (the number of words from a given sentence that were recalled, provided that at least one content word from the sentence was recalled), and a measure of capacity (the number of sentences for which at least one content word was recalled). The capacity measure developed from 7 years onward, even though the knowledge measure was constant across age groups. There is a similar finding using learned pairs or triplets of words or pictures (Cowan et al., 2010, *Developmental Psychology*). In a recognition procedure, Cowan et al. (2015, *Developmental Science*) showed brief, simultaneous arrays of letters or unfamiliar characters followed by a single probe to be judged present or absent from the array and found that, although letters were recalled much better, there were nearly identical growth curves for letters or unfamiliar characters using scores for each item type standardized across age groups. (2) Cowan et al. (2010, 2011, *Developmental Science*) similarly showed the insufficiency of other hypotheses, including encoding speed, rehearsal, and attentional filtering, for both arrays and slower sequences of objects. For example, the relative frequency of testing memory for objects of one or two different shapes was manipulated across trial blocks to observe attention allocation based on utility. (3) The hypothesis proposed here is that what develops is not the number of independent items in working memory, but the completeness of items. Younger children's information about each item may often be

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suboptimal for the test administered. When infants' working memory is loaded with 3 toys, they remember the number of toys but forget their details (Zosh & Feigenson, 2012, *Journal of Experimental Child Psychology*). In adults, for arrays of multifeatured objects, there is partial loss of some objects (Hardman & Cowan, 2015, *Journal of Experimental Psychology: General*). Some features seem to develop more slowly than others; Cowan et al. (2010, *Developmental Science*) found slower development for item location than for shape-color binding. Last, I describe what kinds of experiments are needed to pursue further this hypothesis of the developing richness of item representations.

1-B-23 Effects of handedness on verbal and written language memory

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The purpose of this present study was to examine whether there are any differences in the way left-handed and right-handed individuals remember written and verbal language. Because many neuroscience studies exclude left-handed participants, there is a lack of significant knowledge about such potential differences. This ongoing study has recruited over 25 left-handed participants and 50 right-handed participants; data collection continues, and we anticipate having equal numbers in each group. Handedness is assessed using the Edinburgh Handedness Inventory, and participants also complete the CVLT, a working memory test, and a recall test for information that was presented either verbally or in written form. Preliminary results are showing no significant differences in memory between left-handed and right-handed participants, which is an interesting and important finding. There do appear to be slight differences in CVLT performance, as supported by prior research. Once more participants are tested, we plan to conduct more advanced statistics to better examine these differences.

1-B-24 Exploring analogous problems before lecture enhances metacognition of conceptual knowledge in college physics

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Engineering undergraduates often develop stronger procedural knowledge than conceptual knowledge in their coursework. In a randomized experiment with engineering majors in a college physics course (N = 171), we varied instruction when teaching a new concept (magnetic force). Students assigned to a traditional lesson sequence heard a lecture then practiced solving the new magnetic force problem (instruct-first condition; n = 54). Students assigned to solve the same problem before hearing the lecture either used a structurally analogous electric force problem from a previous unit to help guide them (analogy-first condition; n = 62) or had no analogy while exploring the new problem (explore-first condition; n = 55). Students completed written metacognitive reports about their learning directly after the lesson. In analyzing these reports, we found no association between instruct-first or explore-first students' professed knowledge of the magnitude or direction of electric force and their accuracy in setting up an equation to solve for magnitude and direction of magnetic force. However, we found a positive association between analogy-first students' reports of knowing magnitude and direction of electric force and ability to solve for these components of magnetic force. These findings suggest that metacognition can be enhanced by simultaneous exploration of analogous problem types when learning a new concept, as contrasted with (a) an explicit reminder of the connection between topics through lecture or (b) exploration of a new problem without an analogy to scaffold problem solving.

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1-B-25 Toddlers and preschoolers reason relationally in a causal problem-solving task

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Previous work suggests that preschoolers struggle to learn and transfer abstract relations (e.g. same/different; bigger/smaller than) in the absence of labels or explicit prompts to compare exemplars. However, one recent study finds that 3- and 4-year-olds can succeed in a causal adaptation of a relation-match-to-sample task, where the relations to be learned are operationalized as the difference between the beginning and ending states of a causal transformation. In two experiments, we investigate whether preschoolers and toddlers are able to learn and apply abstract relations in a causal problem solving task. In Exp 1, three-year-olds (N=31, Mage = 41.08 months) were introduced to a toy monkey who "likes to wear hats that fit." The experimenter demonstrated (without relational language) that putting two objects in one of two "change machines" made them bigger, and that putting two identical objects in the other machine made them smaller. At test, the monkey's hat was either too big or too small. The experimenter asked, "Which machine should we put it in to make a hat that fits?" This question required participants both to reason relationally (i.e., about the current versus desired size of the hat), and to reason analogically (i.e., to extend the relations learned in the training to solve the novel problem). Twenty-two out of 31 participants (71%) chose the relevant machine, $t(30) = 2.53$, $p = .017$. Exp 2 (ongoing) aims to replicate Exp 1 in 24-30-month-olds. At test, toddlers use the machine to solve a novel problem (i.e., a shape is too small to activate a music machine). Nineteen out of 25 toddlers (76%) have succeeded, of a planned sample of N=100.

1-B-26 Helping children develop analogical reasoning: Optimal instruction depends on age

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Analogical reasoning - the ability to identify underlying schematic structure shared between representations - is predictive of academic achievement (Richland & Burchinal, 2013), but challenging for children younger than 12 years old (Gentner & Smith, 2013). Here, we ask if a short intervention using co-speech gesture can benefit this ability at different ages. Using a pretest-training-posttest design, 4-12-year-olds solved scene analogies (N=190) with a short training intervention, where they received verbal instruction explaining the underlying relations either with or without accompanying gestures. Visual attention was monitored and children were asked to explain how they solved problems. Results indicate that the effect of the intervention depends on age ($p < .05$), with children under the age of 7 benefiting more from instruction incorporating gesture ($p = .06$), whereas older children benefit equally from either type of instruction ($p = .14$; Figure 1). Ongoing analyses will consider how verbal explanations and visual attention patterns relate to performance.

1-B-27 Neural markers of incidental memory in autism spectrum disorder and Phelan-McDermid syndrome

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Language acquisition in autism spectrum disorder (ASD) is often delayed or absent. Implicit learning contributes to early language acquisition and processing, where regularities and repetition facilitate

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learning. In this study, we probed implicit language learning abilities using electroencephalography in children with idiopathic autism (iASD, $n=11$) and Phelan-McDermid syndrome (PMS, $n=14$), a common monogenic form of ASD. During a passive-listening paradigm, children heard a series of single-syllable non-words on 100 trials. One non-word, randomly selected, was repeated on 50% of those trials. On the remaining 50% a novel non-word was presented. Mean amplitude differences between repeated and single presentation non-words were examined at parietal electrode sites 200-500ms after stimulus onset (Key et al., 2018). We found differential patterns of neural activity between conditions in the iASD group ($t(10)=2.88$, $p=0.016$), with larger amplitude response to repeated non-word versus single presentation non-word stimuli. There were no significant differences between conditions in the PMS group ($t(13)=-0.82$, $p=0.43$). Results suggest a more typical neural response indexing incidental memory for repeated complex sounds in iASD, but not PMS. This paradigm may have utility for assessing language learning in severely affected clinical groups. Findings suggest that an atypical implicit learning and memory response may contribute to distinct language difficulties in PMS compared to iASD.

1-B-28 Children successfully reason about necessary and impossible events, but fail to reason between favorable or unfavorable probabilistic outcomes

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Optimizing decision making under environmental uncertainty requires the analysis of situations that are possible, impossible, and more or less probable or improbable. This ability to analyze uncertainty emerges early in life; 12-month-olds have intuitions about probabilities that guide their expectations without a need for prior sampling (Téglás et al., 2007). By age four, children are able to spontaneously represent and prepare for multiple, mutually exclusive versions of possible future outcomes (Redshaw & Suddendorf, 2016). However, the developmental trajectory of reasoning about mutually exclusive events of differing probabilities remains unknown. Using two side-by-side physical probability "plinko" devices we created a competitive situation where children would need to reason between two different outcome probabilities. 47 3- to 6-year-old children participated in a game that required them to choose between two options in order to maximize or minimize the chances of a desirable (win a cupcake) or undesirable (avoid a hot pepper) outcome. Preliminary results demonstrate that children, like adults, successfully reason about necessary and impossible outcomes, but unlike adults, struggle to accurately reason between two probabilistic outcomes (Figure 1). These results suggest that, for children, necessary and impossible events may be differentiable classes of modal reasoning, distinct from probability computations.

1-B-29 Are children more optimistic about distant versus near future events?

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Although accurately predicting one's future states is essential for decision making (e.g., predicting happiness in a new job), adults and children are overly optimistic about their future (i.e., optimism bias), which can lead to more risk-taking, and less self-protective, behavior (Kos & Clarke, 2001). Notably, adults' optimism bias is tempered by the psychological distance of the future event from the self "here and now" (Gilovich et. al., 1993). This study investigates whether children's predictions about the distant, compared to near, future are more optimistic. Sixty-five (projected $N=80$) 4- to 7-year olds imagined participating in four game-like tasks (e.g., bean bag toss) either "soon" (i.e., near future; $N=32$)

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or "a week from now" (i.e., distant future; $N=33$) and predicted their performance on each task. Results thus far show that children tend to be more optimistic about their performance in the distant ($M=17.15$, $SD=3.14$), compared to near ($M=15.87$, $SD=3.73$), future, although this tendency was not statistically significant, $F(1,57)=1.96$, $p=.17$, $\eta^2=.03$. Regardless of condition, participants were more optimistic when they had control over the outcome of the task ($M=8.74$, $SD=1.83$) than when they did not ($M=7.80$, $SD=2.21$), $F(1,57)=14.25$, $p<.001$, $\eta^2=.20$. This study is the first to examine how psychological distance influences the optimism bias in children, with implications for improving their future-oriented decisions.

1-B-30 The development of flexible problem solving in young children

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Flexible thinking allows individuals to nimbly adapt. Older children can flexibly react to changing task rules in a variety of contexts (Deák & Bauer, 1995; Frye et al., 1995). However, younger children often perseverate, making switch errors on 50-100% of trials (Kirkham & Diamond, 2003). Here, we explored flexible problem-solving in 2-4-year old children, utilizing a puzzle task previously tested with chimpanzees and gorillas (Jacobson & Hopper, 2019). Sixty-one participants ($Mage=3.42$ years, 28 females) were asked to remove physical obstacles to retrieve a reward, only some of which were relevant to the goal. Children became more efficient with age ($r(61)=.44$, $p<.001$), even when the puzzle configuration switched ($r(61)=.47$, $p<.001$). Only 2-year olds became significantly less efficient with a configuration switch ($p=.04$), contrasting with both the older children and previously-tested great apes. These results allow for both a comparative and developmental perspective on cognitive flexibility.

1-B-31 The "Knew-it-all-along error": Young children's difficulty tracking their own or another person's knowledge

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Moments after learning a new fact, 4- and 5-year-olds often claim to have previously known it (Sutherland & Cimpian, 2015; Taylor et al., 1994). We examined this "knew-it-all-along" error by comparing children's monitoring of their own knowledge with their tracking of another individual's knowledge. If this error reflects difficulty monitoring metacognitive cues, children should make the error for judgments about their own knowledge, but not another person's knowledge. However, if children have a more general difficulty relating knowledge to learning episodes, they should make the error for self and other. In Experiment 1, 4- to 5-year-old children ($N=35$) participated in one of two conditions. In the Self condition, children learned 8 new animal facts (e.g., "Chimps crack open kernels"), and judged whether they had known each fact previously. In the Other condition, children and a puppet were taught a fact, and the child judged the puppet's knowledge. Performance did not differ from chance in either condition. In Experiment 2 ($N=32$), only the puppet learned the facts in the Other condition. Performance did not differ from chance in either condition. Children made errors judging both self and other, whether they did or did not share the puppet's knowledge. Thus, children appear to have a general difficulty tracking knowledge, rather than a metacognitive deficit specific to their own knowledge. Chance levels of performance indicate that errors were not a "knew-it-all-along" bias, but instead reflect uncertainty and random responding.

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1-B-32 Is getting it wrong right?: Comparing prompts to explain and predict in children's causal reasoning

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Limited work in preschool-aged children has directly compared prompts to predict with prompts to explain. Although both aid learners in activating prior knowledge (Chi, et al., 1994; Crouch et al., 2004), each may elicit unique processes. Given that children prompted to explain tend to favor prior beliefs over novel observations (Walker et al., 2017), we test whether generating a prediction may make children more likely to override incorrect beliefs compared to generating an explanation. Seventy-one 4-year-olds listened to a story and had to differentiate between two possible causes of a physiological outcome: a psychosomatic cause supported by 100% of the evidence (inconsistent with children's prior beliefs, Schulz et al., 2007), or a food-related cause supported by 75% of the evidence (consistent with prior beliefs). Results in progress reveal that children prompted for a prediction ($n = 24$; $M = 42\%$) selected the psychosomatic cause more often than those who had not seen any evidence (12%), $p < .001$, while those in the explanation ($n = 27$; $M = 26\%$, $p = .07$) and control ($n = 20$; $M = 20\%$, $p = .3$) conditions did not. The overall difference between groups is not yet significant ($p > .29$). Although preliminary, this work suggests that generating a prediction may engage unique processes relative to explanation.

1-B-33 Promoting conceptual change using picture books and guided play in science.

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As early as infancy, children form expectations about physical phenomena (Goswami & Bryant, 2007). Young children develop naïve theories to explain observations which can be used to predict outcomes. In many instances, children's naïve theories include misconceptions, which can interfere with knowledge acquisition and be resistant to change (Pine et al. 2001). A challenge for science education has to do with identifying the best way to teach counterintuitive information. Research has highlighted the crucial role of providing children with viable alternative explanations, to outcompete persistent naïve misconceptions (Brewer et al., 1998; Kelemen, 2019). Picture books (Kelemen et al., 2014; Authors, 2018) and guided play (Authors, in prep) are two pedagogical approaches that can be used to provide causal explanations to help young children revise their misconceptions in one-on-one experiments. The current study expands on this work by exploring the applicability of these methods in a classroom setting. We compare these two approaches, as well as the combination approach because conceptual change is the gradual revision of naïve beliefs that requires prolonged and diverse experiences with the concept in question (Vosniadou, 2013). Therefore, a combination approach may be best because it teaches both scientific content and the scientific process (Weisberg et al., 2013). This study aimed to examine the best instructional approach for belief revision in kindergarten. Three classes of kindergarten children (4-to-6-years-old) heard explanations from two picture books and/or two guided activities for three physics concepts: falling objects, sinking and floating, and balancing objects. Classes participated in one condition (picture books, guided activities, or a combined approach) for each of the 3 concepts. For each concept, the intervention took place in small groups (approximately 5 children) twice a week for two weeks. On Days 1 and 2, the guided activity and picture book conditions completed one of the respective interventions. This was repeated on Days 3 and 4. In the combined condition, children

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were read a book on Day 1 and completed an activity on Day 2. This was repeated with the remaining picture book and guided activity on Days 3 and 4. Children were individually pre-, post- and delay-tested two weeks later, on their ability to make predictions and explain real objects' behaviours (e.g., 'which object would sink, and which would float'). Their explanations were coded on a 3-point scale. A one-way ANOVA revealed no differences between the three conditions at pre-test ($p=.33$). A 3 (test phase) x 3 (condition) mixed ANOVA revealed a significant main effect of test phase ($p<.001$). Children's post- ($M=4.16$, $SD=2.97$), and delay-test ($M=4.55$, $SD=2.66$) scores were significantly higher than their pre-test scores ($M=1.07$, $SD=1.44$). There was no main effect of condition ($p=.27$), but a significant interaction between test phase and condition ($p=.04$; Figure 1). To summarize, at post-test children revised their physical science misconceptions through picture books, guided activities, or the combination of both, however, children in the combined condition retained their knowledge after a delay better than children who received only the picture book or guided activity alone. This research shows the importance of providing children with a variety of instructional approaches that address their intuitive theories for long-lasting conceptual change.

C – Spatial and numerical knowledge

1-C-34 Thinking outside the box: Children's understanding of geometrical rules is not rooted in shapes

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While geometry seems to be part of the human core knowledge, still little is known on how the human brain learns geometrical concepts. A previous study assessing adults' and preschoolers' comprehension of geometrical spatial sequences built on an octagon, exhibited a putative "language of thought" for geometry. This "language" made of primitive and combinatorial rules seemed to develop with age and education. Rotational symmetry and 3-level embeddings were particularly challenging for preschoolers and uneducated adults. In the present experiment, we proposed a short intervention to try and mitigate preschoolers' potential limitation to perceive regularities in sequences using 3-level embedding. We chose a sequence dynamically drawing two perpendicular rectangles and tested whether explicit teaching and labeling of the corresponding static shape (i.e. rectangles) would help children to chunk the sequence. We compared with sequences drawing geometrical shapes that were not taught during the intervention (circle, squares, and crosses), and with a fully irregular sequence. We confirmed that preschoolers identify better than chance sequences using rotations, axial symmetries, and up to 2-level embeddings. However, the explicit knowledge of geometrical shapes did not help them to identify 3-level embeddings. This result tends to show that preschoolers' difficulties do not come from spatial memory span limitations, but from a yet incomplete "language of geometry".

1-C-35 Number understanding among Montessori preschool children

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Early number competence predicts later math achievement. Key number concepts are acquired during the preschool years, including the cardinality principle (CP), or the understanding that the last word spoken while counting a set represents the count of the set, and the successor principle, or the understanding that there is a difference of one between consecutive words on the count list.

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Montessori preschools teach number in a systematic manner using manipulatives which spatially encode and illustrate number regularities, which may influence children's understanding of number concepts. We administered number-related tasks to 25 children enrolled in Montessori preschools ($M = 4;8$ years, $SD = 0;11$ years, range = 3;5-6;0; 13 female). Nearly all children (96%) were CP-knowers as measured through Wynn's (1990) Give-a-Number task. Performance on the Unit Task measuring the successor principle was better than chance, $t(19) = 2.16$, $p = .04$. Moreover, unlike what was observed in a prior study with children attending a conventional preschool (Davidson, Eng & Barner, 2012), there was a significant trend for even low-counting children (i.e., those who could only count to 30 or less) to perform above chance on the Unit Task for items in their count range, $t(15) = 2.05$, $p = .06$. These findings contribute to our understanding of contextual and educational factors potentially influencing the development of abstract number concepts in children. Future work will assess how this performance compares to that of children attending conventional preschools serving a similar demographic.

1-C-36 Math practice and the power of choice: Improving the computational skills of elementary children living in poverty

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Current efforts to improve children's math skills involve rethinking pedagogy and instruction. However, this focus is missing the mark for many children in poverty who are behind in math. Our goal is to shift the focus to practice, which has more potential to reach children in poverty. Rather than dictate children's learning experiences in a top-down manner, practice can provide choices, ultimately increasing motivation. In this paper, we consider a math practice intervention that emphasizes the role of choice. Method. A math practice intervention was implemented three times per week for six weeks during a summer program for children in poverty. Children practiced math using a tablet app and a practice guide. The guide was intended to direct practice sessions, but children were ultimately given the power to practice whatever they chose. Children worked with adult facilitators, whose role was to motivate them to make good choices. Children and facilitators would use the practice guide to find problem sets in the app. At any time, children could exit a problem set and switch to a different one. Data was collected from two sources. The first was practice records from the app, organized according to grade level. The second was a standardized measure of calculation, distributed before and after the intervention (WJ-IV). It was designed to measure computational skills and yields a grade equivalence (GE) score. Results. We looked at what children practiced relative to their pretest GE score. Specifically, what proportion of problem sets were one grade level below their GE (-1), more than one grade level below (<-1), at their GE (0), one grade level above (+1), or more than one grade level above (>+1). We refer to this as the challenge level. To determine how the challenge level influences development of computational skills, we organized children into three groups: those whose skills declined from pretest to posttest, those who remained the same, and those who improved. Children whose skills declined and children who stayed the same spent a similar proportion of practice at a challenge level of -1 (46% and 43%). However, compared to children who stayed the same, children who declined spent a higher proportion at a challenge level of <-1 (23% vs 7%), and a smaller proportion at a challenge level of 0 (23% vs 40%). Practice choice for children who improved looked vastly different. While a similar amount of practice was at challenge level 0 (39%), they practiced less on problem sets below their skill level (12% on <-1 and 24% on -1), and more on problem sets above their skill level (19% on +1 and 6% on >+1) than children who stayed the same (9% on +1 and 1% on >+1) or declined (7% on +1 and 1% on >+1).

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Conclusion. The goal of this paper was to understand if the choices children make in math practice shapes their development. Findings indicate that children who challenge themselves improve as a result of practice. What is not clear is if increased challenge results in learning or if children who choose challenge also possess skills that contribute to their improvement (i.e., resilience). If it is the former, it is easy to restrict choices to be more challenging. If it is the latter, more research is needed to identify the relevant characteristics of children who choose challenge. What is likely is an interaction of the two, where some restriction is effective, but some children will always be more likely to challenge themselves.

1-C-37 The specificity of links between symbolic math understanding and nonsymbolic magnitude representation in elementary-school children

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Numerous studies have shown that children's math performance is associated with their abilities to represent and process discrete nonsymbolic quantities, but the issue concerning the specificity of math measures have rarely been addressed systematically. The current study assessed the 4th and 5th graders' symbolic understandings of two distinct numerical concepts, integers and fractions, respectively, along with their verbal and visuospatial working memory capacities and reading comprehension skills, and randomly assigned them into two groups (A and B), each receiving a different nonsymbolic quantitative task immediately prior to the math tests: A numerosity task for Group A (to estimate the sum of two dot arrays and compare it to a third array) and a proportion task for Group B (to estimate the ratio of a two-parted bar and map its part-whole relation to a position on a bounded horizontal line). Sets of correlational and regression analyses reveal that, for Group A, the acuity of numerosity estimation predicts the integer- as well as the fraction-test performance, whereas for Group B, the precision index of proportion estimation predicts the fraction-test performance only. This pattern holds when the children's age, duration of schooling, working memory capacities, and reading skills are taken into account, indicating a specific link between the proportion-based ability and fraction skills, and a general role of the numerosity-based abilities for both integer and fraction skills.

1-C-38 "I counted with my fingers": The role of domain-general and domain-specific factors in kindergarten children's addition strategy use

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Children use a variety of strategies to solve addition problems and the sophistication of their strategy use relates to problem-solving accuracy. However, previous studies have found differences in accuracy in high- and low-income elementary school students. Therefore, understanding relations between socioeconomic status (SES) and factors influencing children's strategy use is important. The current study examined the role of domain-specific (math) and domain-general (working memory) skills in children's use of addition strategies in relation to SES. Kindergarteners (n=117; 51% male) completed two math measures: number line estimation and magnitude comparison and four working memory measures: counting span, corsi span forward and backward, and a following instructions task. Children also completed 9 simple and 4 complex addition problems. The strategies coded included retrieval, decomposition, guessing, counting in head, verbal and finger counting, and undetermined. Responses

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were scored for accuracy and strategy sophistication. An income-to-needs ratio was used as a measure of SES. A hierarchical regression predicting strategy use from SES, math, and working memory showed that SES did not remain a significant predictor of strategy use when math and working memory were entered in the model, with both variables explaining an additional 41% of the variance ($F(3, 112)=21.82$, $p<.01$). This indicates that domain-specific and domain-general skills predict strategy use beyond SES.

1-C-39 Uncovering a link between mental rotation tests sex differences & declaring entrance into STEM disciplines: Examining & addressing the individual roles of childhood designated spatial activity engagement, spatial/general anxiety, & participant confidence

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Mental rotation is defined as the cognitive ability to rotate 2-D & 3-D object representations in an environment. Research consistently demonstrating males outperforming females on mental rotation tests bespeaks an association with STEM interest (Wai, Lubinski, & Benbow, 2009). Potential variables explaining sex differences include childhood designated spatial activity engagement (Nazareth, Herrera, & Pruden, 2013), spatial/general anxiety (Lawton, 1994), & mental rotation test confidence (Estes & Felker, 2012). We investigate the direct & indirect effects of the recorded variables on MRT differences. 484 undergraduates completed a delegated 24-item questionnaire. Participants reported their confidence level towards MRT execution along with indicating recurring childhood spatial activity exposure & spatial/general anxiety experience. A SEM analysis revealed sex predicting spatial activity ($B=0.21$, $t=4.82$, $p<0.001$) & activity predicting spatial anxiety ($B=-0.14$, $t=-3.07$, $p<0.01$), even when controlling for general anxiety. Further analysis detected activity ($B=0.12$, $t=2.63$, $p<0.01$) & anxiety ($B=-0.25$, $t=-5.54$, $p<0.01$) predicting confidence. Activity ($B=0.10$, $t=2.29$, $p<0.05$), anxiety ($B=-0.26$, $t=-5.75$, $p<0.001$), & confidence ($B=0.60$, $t=16.42$, $p<0.001$) significantly predicted differences exhibited in MRT. Ultimately, we describe the complex interactions between these experiential & affective variables to explain MRT differences in determining a participant STEM interest relation.

1-C-40 Preschoolers' opportunities to learn numeracy and patterning at school

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Little is known about how often preschool teachers provide instruction about specific numeracy and patterning concepts despite research indicating that some numeracy and patterning concepts are unique predictors of preschoolers' later math achievement (Fyfe et al., 2019). Thus, 44 pre-K teachers from 5 public and 7 private schools were asked to report on their numeracy and patterning instruction via a 17-item (see Table 1 for frequency of items). Teachers provided numeracy instruction more often ($M = 13.40$ days per month, $SD = 3.66$) than patterning instruction ($M = 9.93$, $SD = 2.60$), $t(43) = 4.57$, $p < .001$. The numeracy and patterning concepts they taught most often were object counting and identifying patterns, while the least frequent were arithmetic and abstracting patterns. Further, teachers taught foundational numeracy concepts (e.g. rote counting and identifying written numerals) more often than advanced numeracy concepts (e.g. arithmetic and magnitude comparison), $t(43) = 5.99$, $p < .001$. Similarly, they taught foundational patterning concepts (e.g. figuring out what comes next in patterns) more often than advanced patterning concepts (e.g. identifying pattern units), $t(44) = 4.69$, $p < .001$. Results indicate that patterning is a focus of math instruction in preschool, although less than numeracy. Additionally, preschool teachers primarily focus on foundational than advanced math

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concepts suggesting that they may benefit from guidance on children's math learning trajectories (Clements & Sarama, 2008). Future research should examine the frequency of preschool teachers' instruction about other math concepts such as geometry.

1-C-41 How can books improve number knowledge? Aligning spatial features of number lines with a table of contents

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Books, common in children's environments, have spatial features similar to those of number lines, which may support learning about number magnitudes (Thompson, Morris, & Sidney, 2017). In the current study, we evaluated whether an intervention involving a vertical Table of Contents (TOC) listing page numbers in a book improved number line estimation. We randomly assigned 32 Kindergartners (M_{age} = 6.18y; 16 female) to one of two training conditions. Children in the TOC condition were shown how TOC page numbers aligned with decade landmarks on a 0-100 number line (Thompson & Opfer, 2010), whereas children in the counting-on condition practiced counting up from numbers to, and over, decade boundaries in the same range. All children estimated numbers in the 0-100 range at pre- and posttest without feedback. There was no significant difference in children's pretest estimation error. However, after controlling for proportion correct during training (i.e., decades identified on line; counting-on trials), children's estimation error significantly decreased from pre- (M = 23.6%, SE = 1.6%) to posttest (M = 20.4%, SE = 1.7%) in the TOC intervention $F(1, 29) = 11.05$, $p = .002$, $\eta^2 = .28$, but not in the counting-on condition (M_{pre} = 20.0% to M_{post} = 18.4%). Thus, books might support children's emerging literacy and numeracy.

1-C-42 Mapping among number words, number gestures, and nonsymbolic quantities

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Before learning which number words (i.e. one, two, three, etc.) map to which specific quantities, children successfully map number gestures (e.g. holding up three fingers to indicate three) to corresponding quantities (Gunderson et al., 2015) and to corresponding number words (Gibson et al., in prep). Together these two abilities should help children map number words to quantities and thus, may be an early entry point into symbolic number. However, all of these skills have not been measured within the same children. Therefore, in the present study we measured 2.5 to 4.5 year old children's accuracy when matching number words to corresponding quantities, number gestures to corresponding quantities, and number words to number gestures to see when these various skills emerge and how they are related to one another. Preliminary analyses revealed that children are most accurate when matching number gestures to corresponding number words.

1-C-43 Give yourself a hand: Investigating low-income preschoolers' spontaneous gesture use in a numerical task

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Gestures can enhance communication, learning, and general problem solving by reducing cognitive load and conveying a speaker's implicit conceptual knowledge. Prior work has shown a positive relation

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between the number knowledge and spontaneous gesture use during a numerical task of preschoolers from middle- to high-income families. However, less is known about the variability in types and rates of spontaneous gestures in numerical tasks for children from low-income households, who typically perform below their mid-income peers on similar tasks. Head Start preschoolers ($n=70$) were videotaped completing a modified version of the Give-a-Number task to measure their cardinality. Children were asked to create sets of items ranging from 1-8 objects presented in random order, 3 times each for a total of 24 trials. Children also completed Word Span and Corsi-Blocks tasks to assess their working memory. To date, a subset ($n=40$) of these videos were transcribed and coded for children's gesture use. Preliminary results indicate significant variability in children's total use of math-related gestures ($M=3.35$, $SD=4.04$; Range = 0-14). There was a significant positive relation between child age and number knowledge ($r=.74$), as well as child number knowledge and spontaneous gesture use on the task ($r=.37$), similar to prior work with middle- income children. Results will be discussed as to how differences in working memory may relate to spontaneous gesture use in this context.

1-C-44 How many seconds was that? The impact of teaching children about time on their ability to track durations

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Over development, children acquire symbols to represent abstract concepts such as time and number. Despite the importance of quantity symbols, it is unknown how acquiring symbols impacts one's ability to perceive quantities (i.e., nonsymbolic representations). While it has been proposed that learning symbols shapes nonsymbolic quantitative abilities, this hypothesis has been understudied. Moreover, the research in support of this hypothesis has been solely correlational in nature, and thus, experimental manipulations are critical for determining whether this relation is causal. In this study, kindergarteners and first graders ($N = 143$; who have yet to learn about temporal symbols in school) completed a temporal estimation task during which they were trained on (1) temporal symbols and effective timing strategies ("2 seconds" and counting on the beat), (2) temporal symbols only ("2 seconds"), or (3) a control training. Children's nonsymbolic and symbolic timing abilities were also assessed before and after training. Results reveal that children who learned temporal strategies performed better on training tasks and produced less error on the temporal estimation task after training. However, we found no support for the refinement hypothesis as temporal discrimination remained consistent across groups. Although these results provide little evidence for refinement, we were able to train children to use effective timing strategies through a very brief training.

1-C-45 Fraction magnitude: Mapping between symbolic and spatial representations of ratio

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Fraction notation conveys both part-whole ($3/4$ is 3 out of 4) and magnitude information ($3/4$ is equal to 0.75), but accessing magnitude information from fractions may be particularly difficult (e.g., DeWolf et al., 2014; Hurst & Cordes, 2016, 2018). Thus, both educational guidelines and cognitive development research has increased their attention to investigating how we can improve children's magnitude reasoning with fractions. Recent research suggests that using number lines to teach children about fractions can result in better fraction learning than instruction involving more traditional area models (Cramer et al., 2002; Hamdan & Gunderson, 2017; Keijzer & Terwel, 2003; Saxe et al., 2013; Wang &

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Siegler, 2013). In the current study, we investigate how the use of number lines vs. pie charts impacts thinking about rational number magnitudes. We report three experiments investigating how adults (Exp 1, $N = 50$) and children (Exp 2, $N = 70$; Exp 3, $N = 74$) think about symbolic fraction magnitudes. In all three experiments, participants completed a magnitude comparison task in which they were asked to decide which of two values (two fractions or one fraction paired with either a whole number or decimal) is largest as quickly and accurately as possible. In Experiment 1, after completing the task, adults were asked to explain their strategies to explore the relation between spontaneously engaged visualization strategies and symbolic magnitude performance. In Experiments 2 and 3, we had children map rational numbers to number lines or pie charts (between-subjects) before performing the magnitude comparison task to determine whether priming children to use pie charts vs. number lines impacts performance on a subsequent symbolic magnitude task. In Experiment 2, the rational numbers were always fractions between zero and one. In Experiment 3, they were a mix of fractions, decimals, and whole numbers between zero and five. Data reveal that adults rarely spontaneously use number line representations and that providing children with practice mapping rational numbers to number lines did not improve performance on a subsequent symbolic magnitude comparison task relative to practice with mapping the same magnitudes to pie charts. However, in addition to measuring performance, we investigated the external strategies children used with the pie charts and number lines by coding whether they partitioned the representation. For both fractions and decimals in Experiments 2 and 3, children were less likely to use overt partitioning strategies with number lines compared to pie charts. Together, although we did not find strong evidence of a benefit of number lines in this context, we do find that children used the number lines and pie charts differently. In line with the hypothesized mechanisms of the benefits of number lines, children treated the number line as a representation of approximate magnitude, but treated the pie chart as a precise representation of part-whole values. These experiments provide important insight into how these different representations may facilitate thinking about different components of rational number concepts and emphasize the importance of considering variation in the way external representations may be mapped to each other.

1-C-46 Do parents differ in their scaffolding of preschool sons and daughters during a spatial activity?

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Many studies report a male advantage in spatial performance which has been attributed to environmental factors, such as more experience with spatial play and greater exposure to spatial language. In the present study, we compared how parents of preschool-aged children interact with daughters versus sons in a structured spatial task. Participants were 45 (25 girls, 20 boys) 4- and 5-year-olds ($M = 4.82$, $SD = 0.42$) and their parent. Parent-child dyads were invited to create a pattern using magnets of different shapes and sizes. Parents' scaffolding behaviors and speech were coded for gestures, corrections, labeling, and questions. Overall, parents provided more guidance to younger than older children. A significant effect of child sex was found only for iconic parents' gestures, but no other parent behaviors. Parents, whether interacting with a son or daughter, actively guided their children using pedagogical questions, spatial language, gestures, and correction of child errors.

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1-C-47 Teaching infants the meaning of "four"

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Why is learning the meaning of number words so difficult for young children? According to conceptual-change accounts, young children are initially unable to represent exact numbers (e.g., exactly 4), and this numerical knowledge is gradually constructed over a period of several years. According to continuity accounts, in contrast, some understanding of exact number is innate and universal, but young children typically lack clear-cut contrastive evidence for determining which concepts are intended (e.g., the word "four" means exactly 4 as opposed to not 3, more than 3, less than 5, and so on). To be clear, continuity accounts do not claim that concepts such as exactly 4 are innate—they claim only that infants understand what an exact number is and have the capacity to form a concept such as exactly 4 when the situation clearly calls for it. In the present experiments, we focused on one prediction from continuity accounts: Infants should rapidly learn the meaning of a number word if provided with appropriate contrastive evidence. We tested this prediction by attempting to teach 21-month-olds the word "four" in a novel computer-animated training task. To test for generalization in learning, the training task was followed by a standard 4-vs-2 cracker-choice task, which infants of this age typically fail. The training task in our first experiment included 10 trials; half were 4-vs-3 trials and half were 4-vs-5 trials. Each 4-vs-3 trial started with two identical sets of 3 objects (e.g., ducks); one object was then added to one of the sets to create a set of 4. Next, in the anticipatory period, infants heard, "Four! Where's four?" followed by a paused scene. At the end of the anticipatory period, the set with 4 objects was highlighted, and infants heard, "Four, four!" The 4-vs-5 trials started with identical sets of 4 objects, and one object was added to one set to create a set of 5. The order of trials was pseudo-randomized, and the objects and the location of the set of 4 varied across trials. In the cracker-choice task, infants sat at a table and watched an experimenter lower 4 crackers into one container and 2 into another, one cracker at a time; order and side were counterbalanced. The two containers were then moved toward the infants, who were encouraged to choose one. During the first four trials of the training task, infants looked equally at sets of 4 versus sets of 3 or 5 during the anticipatory period. In the next six trials, however, infants looked significantly more at the set of 4, suggesting that they had learned to associate the word "four" with 4 items. In the cracker-choice task, 81% of the infants who made a choice selected the container with 4 crackers, thus showing transfer of learning to a different number task. A second experiment replicated the results of the training and cracker-choice tasks, with 75% of the infants choosing 4 crackers. As a point of comparison, we also tested 21-month-olds in a separate control group that did not receive training. Confirming prior results, only 50% of these control infants chose 4 crackers. Together, our results demonstrate that at 21 months of age, infants can rapidly learn the meaning of the word "four" when provided with contrastive evidence that pinpoints exactly 4 as the intended concept. These results suggest that infants already possess some understanding of exact number and, as such, they support continuity accounts of exact number.

1-C-48 Understanding the development of object fitting: Object structure and spatial process

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In this work, we employed motion-tracking technology to investigate how the three-dimensional spatial structure of an object affects spatial planning. We conducted two studies using an object fitting task. In

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Study 1, we attached a handle orthogonal to a rod and asked 17- to 36-month-old children (N=35) to insert the rod into a tabletop slot. Results indicated that 30-month-old but not younger children consistently pre-aligned the rod with the slot before it contacted the slot, suggesting that the older children planned their actions with respect to the object's overall spatial structure ($p=.006$). In Study 2, we added a handle parallel to the rod or another handle that was perpendicular to the rod. A new sample of 18- to 48-month-old children (N=36) was asked to insert the handled object's rod into a slot. Results indicated that children had more difficulty pre-aligning the rod with the perpendicular than parallel handle ($p=.003$). Children did not consistently pre-align the rod attached to the perpendicular handle until 48 months ($p<.001$), suggesting that the increased complexity of this object interfered with spatial planning. Collectively, the reported studies suggest that during the early years, children become increasingly able to use tools efficiently and plan manual behaviors that are geared to an object's spatial structure.

1-C-49 Children's evaluations of fraction magnitudes in strip diagrams: Strip lengths and visible segments matter

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Strip diagrams are often used to depict and teach about fractions. Previous research has shown that displaying discrete segments in strip diagrams negatively affects magnitude comparison performance (Boyer & Levine, 2015). In this study, 4th- to 6th-grade participants compared fraction magnitudes presented in strip diagrams that varied in the presence of discrete segments and in whether the strips were the same lengths or different lengths. We collected eye movement data as well as reaction time and accuracy data. Participants were less accurate and slower on trials with discrete segments. The negative effect of discreteness on accuracy was stronger on trials on which the depicted fractions were closer in magnitude. Children were more accurate and faster at comparisons of strips that were the same length, and this effect was stronger on trials without discrete segments. Saccade counts and reaction time data suggest that counting strategies were responsible for reduced performance on discrete trials. These findings have implications for how fractions are depicted in visual representations in mathematics curricular materials.

1-C-50 Does spontaneous alignment of fraction representations correlate with fraction understanding?

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Prompting comparisons of fraction representations is a commonly used method for supporting children's fraction understanding. Despite this, few theories suggest ways to optimally arrange representations in space (top-to-bottom, left-to-right). An exception to this is the spatial alignment principle, which suggests that comparison will be more effective when the corresponding parts of each fraction are placed perpendicular to their structural axes (e.g., horizontal line graphs stacked vertically, or vice versa; Matlen et al. 2004). Thus, students who struggle with fractions may be supported when the fractions are spatially aligned. To explore whether students spontaneously align their representations, ninety-seven 6th-8th grade students were given a NAEP multiple-choice problem involving fraction comparison, and were asked to draw a representation to explain their answer. Students' drawings were coded for the representational type (pie, bar, line) and whether

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representations were spatially aligned. Of students who drew multiple representations ($n=59$), only 37% spatially aligned them. Bar and line graphs were more likely to be spatially aligned (78%) than pie graphs (18%). Moreover, students who spatially aligned representations were more likely to accurately solve the problem (77% vs. 62%). These findings are consistent with the idea that spatial alignment may support fraction comparison. They also suggest that bar and line graphs may be more conducive to alignment than pie graphs.

1-C-51 Performance on an AP Statistics practice exam is associated with students' predicted scores and course engagement, not number of math classes previously taken

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Research on accuracy of self-assessment is mixed (Panadero et al., 2016), with evidence that greater math experience correlates with more accurate self-assessment of math performance (Hosein & Harle, 2018). We sought to determine whether (1) students' predicted scores reported 2 months prior to assessment were more accurate than those reported immediately prior; and (2) after accounting for predicted score 2 months prior, to what extent do demographic factors (age, gender, parental education), math experience (classes taken), and engagement in the course (SSE-S; Whitney et al., 2018) account for variation in test performance. Participants included high school students enrolled in an AP statistics courses ($N = 149$, $M(\text{years}) = 16.5$, $SD(\text{years}) = 1.0$, 51.7% female). A William's test for differences between dependent correlations did not find a difference between correlations of actual and predicted AP scores when predictions were made 2 months ($r_{\text{polychoric}} = .67$), or immediately prior ($r_{\text{polychoric}} = .70$) to testing, $t = .98$, $p = .22$. Analysis of variance was conducted using scores from a custom-built computerized assessment of AP statistics as an outcome. Results revealed a significant main effect of predicted score, $F = 6.85$, $p < .001$, and course engagement, $F = 4.05$, $p < .05$. Findings shed light on self-assessment by suggesting it may be predictive of student test performance in specific contexts and stable over discrete spans of time. Course engagement, rather than experience, should be considered when evaluating self-assessment accuracy. Future analyses should examine potential factors that moderate the association between predicted score and actual scores.

1-C-52 Exploring parent-child math engagement in diverse populations

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The home numeracy environment predicts children's math knowledge at the start of school (e.g. LeFevre et al., 2009). However, less is known about the home numeracy environment in families from diverse cultural and socioeconomic (SES) backgrounds. Here we report on two exploratory semi-structured focus groups--one in English and one in Spanish--with African American and Latina primary caregivers (PCGs) of 4- to 7-year-old children from low SES backgrounds aimed at understanding their attitudes about math and how they support their young children's math learning. In initial questionnaires, PCGs ($n=18$) reported feeling a wide range of math anxiety ($M=4.8$, $SD=2.83$, range=1-10), with Spanish speakers reporting higher anxiety ($n=8$, $MSS=6.0$, $SD=3.07$) than English speakers ($n=10$, $MES=3.9$, $SD=2.38$). However, Spanish speakers and English speakers did not differ in their reports of knowing which activities will get their children interested in math ($MSS=4.75$, $SD=1.04$; $MES=4.9$, $SD=1.20$). Focus group questions prompted PCGs to discuss their attitudes towards math and

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how those attitudes influence the way they engage in math with their children. PCGs described engaging their children in a wide range of math activities and were motivated to learn new ways to support their children's early math learning. Insights from these focus groups have important implications for thinking about ways to intervene to enhance the home math environments of young children from diverse backgrounds by building on PCGs' math strengths and interests, and by addressing their math anxiety.

1-C-53 Executive functioning moderates the effect of parental elicitation of math concepts on preschoolers' math performance

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Early math skills are a strong predictor of later educational outcomes, and variability in math performance is already present by kindergarten entry (Jordan et al., 2006, 2009). Prior work has examined the role of the home numeracy environment in preschool math achievement and has found that higher parental use of math talk (using number words and asking questions related to math concepts) predicts better math outcomes (e.g., Levine et al. 2010; Elliott et al., 2017; Gunderson & Levine, 2011). Previous studies have exclusively considered the frequency of number words, or combined math words and questions. Here, we specifically examine parental use of math-related elicitations (questions and commands intended to evoke a response using math concepts) during a free play interaction with their preschool child (124 parent-child dyads; child M age=3.9 yrs). We find that parental use of math elicitations predicts children's math performance on the TEMA-3 (Baroody & Ginsburg, 2003), but only for children who have high executive functioning, as measured on a modified Day-Night-Stroop test (Gerstadt et al., 1994). This effect holds even when controlling for children's other general cognitive abilities as well as parents' own math abilities and their overall quantity of talk during the interaction, $F(6,117)=2.83$, $p=.01$. Thus, parental math input may only be useful for children who have the domain-general cognitive propensity to benefit from the engagement.

1-C-54 Gesture in instruction equalizes the socioeconomic playing field for math learning

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How can we improve math learning? Recent research shows that when teachers gesture during math and science instruction children improve in conceptual understanding. However, a host of other sociocultural factors have also been shown to impact learning. For example, children struggle in math when: (1) from a one versus two parent household and (2) parents have not attended college. We asked whether gesture can help scaffold math learning for children with limited social resources? We randomly assigned classrooms to speech only versus speech and gesture instruction of mathematical equivalence (understanding the meaning of the equal sign). We also examined how instruction effected learning when certain parental factors varied (i.e., parents' education and household structure). We examined 234 children from Chicago area second grade classrooms (children ages 7-9), using a pretest-instruction-posttest design. Parent(s) were surveyed on whether the household consisted of one or two parents and whether parents attended college. Learning was operationalized as an increase in correct math solutions after exposure to instruction. Analyses showed that for children from single parent households and whose parents did not go to college, speech instruction with gesture resulted in a significant increase of correct solutions compared to speech instruction without gesture. In contrast, for

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children with two parents who both went to college, the same increase in correct solutions occurred whether or not gesture accompanied speech instruction.

1-C-55 Children's number representations influence the accuracy of their numerical predictions

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Children generate numerical predictions quickly, accurately, and without deliberate processing (Griffiths & Tenenbaum, 2006; Masnick & Morris, 2008). Children's number representations become more accurate throughout development, initially showing linear representations for relatively smaller numbers (0-100) and logarithmic compression for larger numbers (700-1000; Siegler, Thompson, & Opfer, 2009). However, it is unclear whether numerical prediction accuracy is associated with number representation accuracy. To that end, we investigated the relation between the accuracy of children's individual number representation and the accuracy of their numerical predictions. If the two are positively related, then inaccurate number representations should be associated with inaccurate predictions. Participants included 127 third, fourth, fifth, and sixth graders (see Table 1 for demographics). Each participant completed a number line and numerical prediction task. The number line task required children to estimate the placement of a number (0-1000) on a number line whereas in the numerical prediction task children were asked to predict how far they thought a ball would travel based on a player's previous batting distances (i.e., home run derby task; Masnick & Morris, 2008). Participants made their predictions based on sets of 4, 5, 8, 9, 12, and 13 distances. Two measures were calculated: percent absolute error (PAE) (number line task) and prediction error (numerical prediction task). PAE was calculated by subtracting the number line estimate from the target number divided by 100. Prediction error was calculated by subtracting the prediction from the set mean divided by the set mean. A linear mixed random effects model was used to evaluate prediction error as a function of number set size by number line PAE with grade level and gender as covariates. Subject and item were nested as the random intercept. This model revealed a number of main effects and interactions, which accounted for approximately 35% of the variance in prediction error. Critically, there was a main effect of number line PAE, such that as PAE increases, there was a significant increase in prediction error ($p = .002$). The results suggest that the accuracy of individual number representations influences the accuracy of numerical predictions. One possibility is that numerical predictions emerge from the representation of multiple numbers, thus errors in individual numbers will be magnified in subsequent numerical predictions. References Griffiths, T. L., & Tenenbaum, J. B. (2006). Optimal predictions in everyday cognition. *Psychological Science*, 17(9), 767-773. Masnick, A. M., & Morris, B. J. (2008). Investigating the development of data evaluation: The role of data characteristics. *Child Development*, 79(4), 1032-1048. Siegler, R.S., Thompson, C.A., Opfer, J.E. (2009). The logarithmic-to-linear shift: One learning sequence, many tasks, many time scales. *Mind, Brain, and Education*, 3, 143-150.

1-C-56 Does parents' spatial language relate to parent and child gender?

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Spatial language has been shown to support spatial thinking, which is an important predictor of STEM achievement. In prior work, parent spatial language predicted child spatial language use and differed by child gender (e.g., Pruden & Levine, 2017). These studies, however, were conducted in home

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environments where the types of activities could also vary by child gender. We examined these effects in a controlled context. We coded videotapes of 40 first-graders (22 females) completing three spatial-related tasks separately with their mothers and fathers as part of the NICHD Study of Early Child Care and Youth Development (Inter-coder reliability > 0.85). We targeted terms that encoded shapes, dimensions, and spatial properties of objects. Child spatial language types were significantly related to fathers' types ($r(37)=.57$, $p<.001$), but not mothers' ($r(37)=.24$, $p=.140$), controlling for parent and child total utterances. Controlling for parent total utterances, we found no difference in parent spatial types by child gender ($F(1, 37) = 0.23$, $p = .637$). Additionally, mothers provided more spatial types than fathers ($F(1, 37) = 13.95$, $p < .001$). This suggests that child gender differences in prior studies may have been a result of differential engagement in the types of activities that elicit spatial language. Future research should examine gender differences among parents, and whether parent spatial language predicts child spatial skills when the type of activity is controlled.

1-C-57 The role of parents' conversational style in children's' mathematics achievement

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The language to which children are exposed at home and school is associated with variations in mathematics achievement in the elementary years (e.g. Thompson, Napoli, & Purpura, 2017; Grammer, et al., 2016). In addition, the ways in which parents talk with their children about past experiences have been linked to differences in children's memory skills. Research has shown that parents who use more metamemory talk (references to the process of remembering), have children who are more engaged in recalling information than children of parents using less metamemory talk (Hudson, Coffman, & Ornstein, 2018). These enhanced memory skills, which are driven by parent-child conversations, may also be an essential key to children's overall mathematics achievement. A sample of 51 kindergarteners from a longitudinal study were assessed at multiple timepoints with a broad cognitive battery, including tasks to assess mathematical fluency and calculation. Children also completed a reminiscing task about a shared event with a parent. Preliminary analysis indicates that children of highly elaborative parents (parents who pose more wh- questions) during conversations about the past evidence higher skills in math calculation ($M=14.63$, $SD=3.93$) and math fluency ($M=17.58$, $SD=9.83$) than math calculation ($M=11.24$, $SD=4.99$) and math fluency ($M=10.40$, $SD=6.39$) skills for children of low elaborating parents. This supports previous claims that parents' conversational style is associated with children's mathematical achievement and also presents novel ideas about the type of language that leads to this influence.

1-C-58 Exploring the link between patterning, numeracy, and math knowledge

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While most research focuses on the contributions of early numeracy to mathematics development, emerging research suggests pre-K patterning skills also predict concurrent and later math knowledge. Why this link exists, however, is unclear. The current study evaluated the relation between patterning and general and specific aspects of math knowledge. Preschoolers ($N = 212$, $Mage=4.7$ years, $SD= .37$) were assessed on their repeating patterning skills, general math and numeracy knowledge, and specific aspects of numeracy at one time point (Table 1). Raw and partial correlations controlling for age suggested that patterning skills correlated with general math and numeracy knowledge and specific

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aspects of numeracy (i.e., successor principle knowledge, and highest count up to 50 (Table 1). Regression analyses controlling for age showed that patterning and specific aspects of numeracy each uniquely predicted general math and numeracy knowledge (Table 2). Findings align with past experimental and longitudinal work suggesting that patterning is important for early general math and numeracy. The association with counting and the successor principle suggests that patterning may help children develop numeracy knowledge through the role of rules and regularities in both patterning and numeracy. Findings further suggest that patterning should be included in early math standards and theory.

D - Linguistic and conceptual development

1-D-59 Pure mediated semantic language activation in toddlers

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At the second year of life, toddlers are sensitive to direct relationships between words at the phonological (cat-cap), semantic (cat-dog) and associative (dog-bone) levels; but also, to between-level indirect relationship, in which the relationship is established via a mediator as phonological-semantic (cup-cat-dog) and semantic-phonological (dog-cat-cup). Theoretical models and previous research in adults showed within-level mediated activation between words. Therefore, the present research aimed at investigating within-level mediated activation at the semantic level in a primed IPL task -with eight trials of 2000 ms each- in 24-month-old toddlers. Toddlers heard a prime word followed by a visual display that simultaneously presented two pictures (target and distractor) with an auditive word (target name). There were two types of trials: In Related trials, the named target (cheese) was related to the prime (dog) through a mediator (cat); in contrast, in Unrelated trials the named target was unrelated to the prime. Pupil size was measured during the presentation of the trials and it was analysed by a temporal non-parametric cluster-based statistical test. Results showed that the Related trials have greater pupil dilation than Unrelated trials from ~600 to ~1900 ms ($p = .04$). Thus, 24-month-old toddlers are sensitive to semantic within-level relationships between words. The significance of the current outcome is that interaction within processing levels are a basic architectural feature of the mental lexicon in early development.

1-D-60 The role of conceptual development and caregiver talk in children's naturalistic artifact learning

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From works of art to simple machines, children have a lot to learn about artifacts. But, how are their learning opportunities shaped by their conceptual development? What role do caregivers play? We examined children's naturalistic interactions with educators and caregivers in a living history museum as they explored artifacts. In our study, 40 caregiver-educator-child triads ($R=4;22-8;0$, $Mage=5.98$) visited two exhibits for 8 minutes each (i.e., a heritage store and house). Using a series of GEEs and correlational analyses, we found: Children's function and purpose related artifact talk increased with age ($ps < .006$), but their identification and composition related talk did not ($ps > .497$), aligning with previously documented conceptual gains in artifact understanding (e.g., German & Johnson, 2002). Caregivers and educators provided unique opportunities for learning by discussing topics at different rates ($ps < .01$).

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Caregivers used different pedagogical techniques to teach their children about different artifact properties. Namely, they used causal ($r_s=.49, p<.001$) and procedural information ($r_s=.60, p<.001$) to describe an artifact's function, but used questions ($r_s=.79, p<.001$) and comparisons ($r_s=.64, p<.001$) to discuss an artifact's identity. This work expands upon the literature on children's artifact reasoning (Greif et al., 2006), and their caregivers role (Nelson & O'Neil, 2005).

1-D-61 Learning minimal pair object-label associations from audiovisual speech

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Within the first two years of life, infants become experts at learning associations between objects and words. At 14-months, infants readily learn novel object-label pairs, unless the novel labels are minimal pairs--words that differ by a single phoneme (e.g., bih vs dih). Here, we test the hypothesis that audiovisual speech facilitates minimal pair learning, based on evidence that multimodal sensory information may facilitate learning. We assess 14-month-old's ability to learn minimal pairs, using the Switch Task, across a visually distinctive condition with different visual places of articulation (bin vs din), and a visually similar condition (bin vs pin) with similar articulatory movements. Pilot data ($n=9$) suggest consistent and distinct looking time preferences across conditions: a looking time preference for Same test trials in the visually distinctive condition (Same $M=11.3$, $SD=3.3$ s., Switch $M=8.8$, $SD=1.5$ s.) and a Switch looking time preference in the visually similar condition (Same $M=6.7$, $SD=3.5$ s., Switch $M=10.9$, $SD=3.0$ s.). These data suggest a potential interaction between conditions, and this interaction is seemingly robust--every participant in the visually distinctive condition ($n=5$) looked longer for Same trials, and every participant in the visually similar condition ($n=4$) looked longer for Switch trials. We are currently running our full sample of 32 infants (16 per condition) and plan to complete data collection in the upcoming months.

1-D-62 Comparing events separated by delays when learning verbs: Does experience with high similarity comparisons help?

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Children learning a verb may benefit from hearing it across different situations (e.g., Behrend, 1995; Childers & Paik, 2009; Scott & Fisher, 2012). However, comparing events is difficult, and events to be compared are often separated in time. In structural alignment theory (e.g., Gentner, 1989), observers learn how to compare by comparing similar examples (progressive alignment or PA). The present study asks whether this helps in verb learning and whether comparison is affected when there are delays between related events. Two½- ($n=16$), 3½- ($n=22$), and 4½- ($n=11$) year-olds were shown video events linked to a verb on a tablet. In one condition, they saw two similar then two varied events (PA); in the other, they saw all varied events (All Far or AF). Events were separated by a 1-minute distractor video; they pointed to one of two videos at test. This was repeated for a second verb. A 3 (Age: 2½-, 3½-, 4½-year-olds) X 2 (Condition: PA, AF) univariate ANOVA showed main effects of Age, $F(2, 43)=3.30$, $p<.05$, and Condition, $F(1, 43)= 6.18$, $p<.02$. Verb learning improved with age, and children in the PA condition benefitted. Although verb studies often show children related events one after another, delays between events are common in everyday life. This study shows how children may learn to use information across instances and over time during verb acquisition.

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1-D-63 Do bilinguals and musicians have better sensitivity to distributional information in learning non-native phonemes?

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A sensitivity to distributional properties of phonetic tokens leads learners to induce underlying phonemic categories - e.g., in babies and adults, exposure to a continuum from da to ta with a bimodal distribution leads to better discrimination of end-point da & ta tokens than a unimodal exposure (Maye, Werker, & Gerken, 2002; Maye & Gerken, 2001). Given that both individuals with musical experience and multilinguals show advantages in a variety of linguistic tasks (Patel, 2011; Byers-Heinlein & Lew-Williams, 2013), we investigate if these populations show better distributional learning. We exposed participants to unimodal or bimodal distributions of phones from a Hindi ba-pa continuum, presented either as a monotonous list, or in a musical context where the varying pitch of each token formed a melodic contour. We had three groups of participants - controls, participants with musical experience, and bilinguals. Participants were assigned to each of the four Distribution X Melody conditions. The results indicated that musical presentation of tokens didn't lead to better discrimination in any of the three groups compared to monotonous presentation. However, in the monotonous exposure alone, individuals with musical experience showed better discrimination in the bimodal compared to the unimodal condition, and bilinguals showed a similar but marginal effect; while there was no difference between bimodal and unimodal conditions in controls. We will discuss aspects of musical experience and native phonology that could affect distributional learning.

1-D-64 Relations between early and later domain-specific higher-order thinking

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In addition to domain-specific content knowledge, domain-general higher-order thinking (HOT) skills--reasoning with and about relations--are necessary for school success. Children's HOT abilities vary widely at school entry, and disparities in early HOT influence later reasoning outcomes (Frausel et al., in prep). Parents may play a crucial role in encouraging children's HOT in some domains but not others. We examine children's domain-specific HOT longitudinally with a diverse sample of 50 parent-child dyads. We recorded 90-minute spontaneous interactions every 4 months from 14-58 months; speech was coded for HOT talk (using 4 relation types: inference, comparison, abstraction, hierarchy) and conversation domain (i.e. topic). At age 11, dyads were visited again and given 12 tasks designed to elicit HOT in 4 domains (math, science, art, social); e.g. in one math task, dyads solved a probability problem with dice. Our key findings are: 1) In early childhood, some domains encourage more spontaneous HOT than others, particularly science (e.g. "deserts are too dry for worms"). HOT use in other domains, such as math, was less frequent. 2) Early HOT input predicts later child HOT in science and social, but not math or art (Table 1), suggesting parents may play a crucial role in supporting HOT in particular domains. If parents believe domains like math are the purview of schooling, they may use less HOT talk with toddlers in these domains, potentially affecting later school success.

1-D-65 Novel word retention in young children is affected by the number of words presented at training

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Research suggests that the number of objects presented and labeled at learning significantly affects encoding (Axelsson & Horst, 2013). However, we do not know whether the amount of words being taught affects long-term retention. The current study addresses this question. 62 children aged 3-6 years were exposed to 4 novel objects, but were given a label for either 2 or 4 objects. Participants were then tested immediately via a four-alternative forced-choice task. One week later, participants were tested on their retention of novel words. Data were analyzed with a binomial mixed-effects model with Phase (Encoding vs. Retention) and Condition (2 vs. 4) as fixed effects and Phase by participant and Phase by label as random effects. Participants performed significantly better in the Encoding phase than in the Retention phase ($p=0.026$). Participants performed above chance in the Retention phase in the 2 label condition but did not perform above chance in the 4 label condition (see Figure). These findings suggest that the number of words a child is taught affects not only encoding but retention as well.

1-D-66 Word learning and sleep in habitually and non-habitually napping children

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Daytime napping contributes to memory in children. Importantly, children transition out of regular napping between ages 3-5 years, and the impact of this transition on memory is unclear. Here we examined the performance of both non-habitually napping children (nap 0-3 days per week) and habitually napping children (nap 4-7 days per week) on a word learning task after a delay including either sleep or wake. Children ages 3.5-4.5 years were given a brief exposure to two novel labels and their referents during training, a scenario that replicates learning experiences children encounter every day. After a 4-hour delay, children were tested on the object-label associations. There was a significant effect of napping status on performance, $F(3, 49) = 6.14$, $p < .001$. Non-habitually napping children did equally well regardless of whether they napped or stayed awake during the delay ($M = 86\%$ and 88% , respectively). However, delay type did matter for habitually napping children, such that habitually napping children who napped after learning outperformed those that stayed awake ($M = 86\%$ and 46% , respectively, $p < .05$). These results suggest that as children transition out of naps, they may be less susceptible to interference and are better able to retain newly learned information across a delay including wake.

1-D-67 Is children's referential communication affected by a conversational partner's helpfulness?

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In everyday interactions, speakers often violate conversational expectations (e.g., by offering less information than listeners need; Grice, 1975). Although children are sensitive to such violations (Gweon & Asaba, 2018; Katsos & Bishop, 2011), how they would respond to them in a reciprocal conversational setting is unknown. We asked whether children tailor the informativeness of their speech based on the informativeness of an interlocutor in a prior interaction. In an informativeness rating task, 4- and 5-year-old children were asked to locate hidden stickers by following two puppets' instructions (one puppet always gave informative instructions; the other always under-informative instructions; Fig.1) and rate each puppet's helpfulness (with a big/small reward). Then, in a referential communication task, roles were reversed, and children helped either the informative or the under-informative puppet uniquely identify a target object by using the appropriate modifier (Fig.2). Preliminary results ($n=26$) show that

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children were overall sensitive to each puppets' informativeness (i.e., they gave them appropriate rewards; Table 1). Crucially, children mentioned modifiers more frequently when communicating with the informative than the under-informative puppet (.29 vs. .13, $p=.011$, Fig.3). Thus, children are not only sensitive to violations of informativeness but also use this partner-specific information to guide their linguistic behavior.

1-D-68 Effects of age and explanatory prompting on preschoolers' ability to use probabilistic evidence to maintain and change beliefs

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The preschool period is a time of considerable conceptual change. A potential explanation for this is a gain in children's abilities to either maintain or change their beliefs in response to noisy, probabilistic evidence about the validity of those beliefs. In Study 1 ($n = 62$), we assessed 4- and 5-year-olds' capacity for belief change using a task similar to a reversal-learning task. Children were asked to find a target color of fish in one of two ponds. Initially they received deterministic evidence about the distribution of fish, which then became probabilistic. In the consistent condition, the probabilistic evidence aligned with children's initial beliefs: there were more target fish in the pond that was initially associated with target fish. In the inconsistent condition, the bias in the ponds was reversed such that children had to revise their beliefs about which pond was best for finding target fish. We found evidence that while both age groups maintained their initial beliefs in response to the probabilistic evidence in the consistent condition, only 5-year-olds updated showed evidence of changing their beliefs in the inconsistent condition. In study 2 ($n = 49$) 4-year-olds' capacity for belief change in a similar paradigm was not improved by an experimenter's prompts to explain their beliefs. The implications of these age-related changes in preschoolers' ability to change beliefs in response to probabilistic evidence are discussed.

1-D-69 Abstract thinking, concrete effects: Dimensions on which stimuli vary determines whether or not children engage relational reasoning

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Relational-Match-to-Sample (RMTS) is the paradigmatic task used to assess the capacity for relational reasoning, an ability underpinning much of human-unique cognition. Preschoolers persistently fail RMTS, suggesting *prima facie* that relational reasoning relies on capacities that develop only after age five. However, four-year-olds can, in fact, succeed on RMTS, e.g. after receiving direct instructions (Kroupin, in prep). So why do children otherwise fail RMTS? Children find shape and color highly salient as bases of matching (Chen & Mazzocco, 2017). Traditionally, items in RMTS tasks vary on shape and color - children may prefer partial matches on those dimensions (e.g. 'both cards have pointy shapes') over relational matches. Thus, children may succeed on RMTS if shape and color are held constant in each trial and items instead vary only a dimension they are unlikely to attend to, namely size. Preliminary results provide dramatic support for this hypothesis: 7/9 (78%) of children have succeeded above chance (i.e. chose correctly on +7/8 trials) on the size-only RMTS task, compared with 1/24 (4%) in control. Simply changing dimensions in which a relational reasoning task is expressed transforms children's persistent failure to employ relational reasoning into robust, spontaneous success. This result has both critical import for task design and broader implications for our understanding of how and when individuals come to successfully employ relational reasoning.

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1-D-70 Which words matter for children's science learning? An analysis of children's vocabulary, science knowledge, and children's science books

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Achievement gaps are a well-known problem in science education (U.S. Department of Education, 2000). Research has suggested that science achievement gaps are present by kindergarten, persist into high school, and are largely explained by children's kindergarten science knowledge (Morgan et al., 2016). The current study investigates what might occur in early childhood to cause these differences in science knowledge. As the science knowledge questions used to assess children are typically vocabulary questions (Morgan et al., 2016), we predicted that science vocabulary may be driving children's science learning. The participants were 93 children between ages 4 and 12 (60 males, Mage=88 months). Children completed three tasks in a random order: a Draw-A-Scientist task in which children drew two scientists, a general receptive vocabulary test (PPVT), and a standardized science knowledge test (Woodcock Johnson-Science Test). Parents also completed a demographics questionnaire and a science vocabulary checklist, which asked them to indicate science words that they had heard their child say out loud. 440 undergraduate students were asked to rate how important the words from this checklist were to children's science learning. Additionally, we recorded how often these words appeared in 45 randomly selected children's science books. Taken together, these measures allow us to determine whether there are parallels between the words children know, what words adults believe are important for children's science learning, and what words are depicted most often in juvenile science literature. Results of linear regression models with Woodcock Johnson-Science Test performance as th

1-D-71 Parents adapt their referential expressions to children's developmental level

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How do parents and children come to communicate effectively about novel objects? While adults readily form temporary agreements on referent names (conceptual pacts), young children struggle to do so with their peers (Clark & Wilkes-Gibbs, 1986; Glucksberg & Krauss, 1966). Can parents play a facilitatory role, scaffolding referential communication to help their children successfully form conceptual pacts? We invited parents and their children (ages 4, 6, and 8) to play a game in which they took turns communicating about novel tangram referents. Across all age groups, dyads (n = 60) used shorter referring expressions as the game progressed, indicating convergence on more efficient reference over time. Parents of younger children (but not younger children themselves) produced longer referring expressions overall, suggesting that parents were adapting language to their children's abilities. Ongoing qualitative analyses will shed light on to how patterns and content of referential communication change as children develop. Overall, parents and their children can converge on efficient reference for novel objects, a skill that children struggle with in peer interactions. Further, our analyses suggest that this may be facilitated by parents adapting to their children's developing communicative abilities.

1-D-72 Using predictive cues to learn prepositions from storybooks

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Language has the power to shape the way people organize their thoughts and concepts. Some concepts, like spatial words, are categorized differently cross-linguistically. Conflicting language-to-concept mappings, such as the Spanish "en" translating to both "in" and "on", may pose difficulty to Spanish speakers learning English. This study investigated how predictive cues help children learn prepositions. Three-year-olds were read preposition books that were arranged in one of two conditions: predictive or control. The predictive condition had each instance of "in" appear with one set of predictive cues (e.g., "Bear put the apple in the box", blue page) and each instance of "on" appear with a separate set of predictive cues (e.g., "Penguin put the ball on the grass", green page). The control condition eliminated the predictive cues by presenting instances of "in" and "on" with all cues. This study informs our understanding of strategies to improve the learning of spatial words in everyday adult-child interactions.

1-D-73 Relations between parent-child interaction, language development, and self-regulation

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High-quality interactions between parents and children support both language (e.g. Hirsh-Pasek et al., 2015) and self-regulation (e.g., Bernier et al., 2010), although it is not clear if this is a directional relation or a reciprocal one. Self-regulation might support language by helping children to attend to and process speech (Raver et al., 2011). Or better language may help children regulate attention and behavior (Zelazo, 2015; Roben et al., 2013). Here, we examine how parent-child interaction relates to 1) self-regulation through language and 2) language through self-regulation. Data were drawn from a subsample of the NICHD Study of Early Child Care and Youth Development (n=187). Parent-child interaction at 24-months was assessed to measure their communication foundation (CF; Hirsh-Pasek et al., 2015). Self-regulation at 36-months was measured by a compliance task (Vaughn et al., 1984) and at 54-months by a delay of gratification task (Mischel, 1974). Language at 36-months was measured by the Reynell Developmental Language Scales and at 54-months by the Preschool Language Scales. Cross-lagged SEM results indicate a nonsignificant indirect effect from CF to self-regulation through language ($B = -.022$, S.E. = .029, $p = .460$) and a trending indirect effect from CF to language through self-regulation ($B = .050$, S.E. = .026, $p = .056$), suggesting that parent-child interaction might support language in part through supporting children's emerging self-regulation skills.

1-D-74 Child language input does not reflect world frequency: Typical and atypical feature description across development

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Language provides children a powerful source of information about the world. From language alone, simple distributional learning models can recover enough information to perform comparably to non-native college applicants on the TOEFL (Landauer & Dumais, 1997). Blind children learn the same kinds of relationships among perceptual categories as sighted children, without any of the relevant visual input (Landau & Gleitman, 1985). However, language does not perfectly reflect the world: the most typical features of natural kinds may often go unremarked. For instance, adults rarely describe the color of an orange carrot, as world knowledge makes this description redundant. Given children's nascent world knowledge, does parents' speech to children follow this pattern? From longitudinal corpus data of parent-child communication (Goldin-Meadow et al., 2014) between 14-58 months, we extracted usage

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data for 684 high-frequency concrete nouns and co-occurring adjectives. Independent raters coded the typicality of over 2,000 unique adjective-noun pairs on a 7-point Likert scale (interrater reliability: $r = 0.8$ in a subset of the data). If language statistics reflect world statistics, description should be dominated by the typical (strong negative skew); however, across all ages, we see descriptors concentrated in the atypical range (positive skewness = 0.38). Parents were reliably more likely to use typical descriptors when talking to younger rather than older children. Overall, child language input reflects notable more than typical features, but increased description of typical features early in development may provide a foothold for young learners.

1-D-75 The role of causal theories of body size in the development of anti-fat bias

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Anti-fat bias is present in children as young as three and persists through adulthood. However, little is known about the cognitive mechanisms involved in the development of this bias, nor about effective approaches to reducing it. In the present studies, we explore children's theories about the causes of body size (Studies 1 and 2) and how these theories impact anti-fat bias (Study 3) over development. We assessed 4- to 11-year-olds' and adults' baseline biological causal theories (Study 1; $n = 184$), or their belief that body size is inherited and biologically determined, as well as their baseline behavioral causal theories (Study 2; $n = 187$), or their belief that body size is determined by one's behaviors. Finally, we investigated how each causal theory impacts anti-fat bias (Study 3; $n = 208$). Studies 1 and 2 found that both biological and behavioral causal theories were held from an early age, with even the youngest children understanding both biological and behavioral causes for body size. Study 3 found that, relative to a control group, biological explanations reduced anti-fat bias and behavioral explanations increased anti-fat bias, across childhood. While the bias-reducing impact of biological explanations was stable across childhood, the bias-promoting impact of behavioral explanations increased marginally over the childhood years. Results have implications for health education, bias intervention, and basic research on causal reasoning.

1-D-76 Effects of financial concerns on low-income parents' speech to children

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Extensive research has investigated the profound effects that early differences in language input have on later development and documented sizable differences in the input that children receive in families of high- vs. low-socioeconomic status (e.g., Hart & Risley, 1995). However, less attention has been devoted to the question of why differences emerge. We tested the hypothesis that financial concerns capture the attention of parents living in poverty (e.g., Shah et al., 2012) and affect the language input they provide for their children. In our study, low-income parents ($n=25$) responded to hypothetical scenarios that described challenging everyday situations that were either financial (Financial condition) or non-financial (Control condition) and then were asked to play freely with their children. Parents in the Financial condition produced significantly fewer words in the minutes following the scenarios compared to baseline measures of language use [$t(11)=-2.14$, $p=.028$], while parents in the Control condition showed no decrease [$t(12)=.11$, $p=.92$]. These results suggest that when low-income parents think about their scarce financial resources, they may become consumed to a degree that impacts their interactions

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with their children. Thus, we suggest that real-life burdens faced by parents in poverty may contribute to widely-discussed SES-related differences in language use and long-term outcomes.

1-D-77 SES and gender influence grade school word learning

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Background: In grade school, children display significant variability in their ability to learn new words. Because this skill is essential to reading comprehension and overall academic success (Hemphill & Tivnan, 2008; Maguire et al., 2018) it is important to identify factors that contribute to that variability. Here we study two potential factors: gender (Kaushanskaya, Marian, & Yoo, 2011) and socioeconomic status (SES; Maguire, et al., 2018). **Methods:** One hundred fifteen 8-15-year-old boys and girls from diverse socioeconomic backgrounds read sentence triplets that ended with a made-up word and were asked to determine the meaning of that word. Performance was compared across gender, SES and age. **Results:** A univariate analysis of variance on percent correct, revealed significant main effects of gender $F(1, 100) = 10.79, p < .01$ and SES $F(1, 100) = 3.95, p = .05$ as well as an interaction between gender and SES $F(1, 100) = 6.25, p = .01$. **Conclusion:** As Figure 1 highlights, boys from low income homes are significantly worse at identifying the unknown word's meaning than their female peers ($p = .05$), a difference not seen in boys and girls from higher SES homes ($p = .25$). This finding suggests that, in particular, boys from low income homes may be at increased risk related to word learning. Specific outreach to this population may help close the SES gap in vocabulary knowledge.

1-D-78 Mother-child conversations about the impact of food and activities on wellness

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Mother-child conversations about the impact of food and activities on wellness What kinds of input do mothers give their preschoolers about the role of food and activities on wellness? The cognitive developmental literature has primarily focused on children's knowledge about the role of food and to a lesser extent activities on body size but there has been no empirical research that has examined the kind(s) of input mothers give their children about the attributes of nutrition and activities on wellness. Birch and Fisher (2000) have highlighted the importance of maternal input on preschoolers' conceptual development about food. The following two studies examine mother-child conversations about the role of food and activities on wellness. Study 1 presented 4-5 year olds and their mothers ($n = 35$ dyads) with a picture book that presented vignettes of children eating either a healthy or unhealthy food on a short or long-term basis (John ate a lot of candy today (short-term) vs. John eats a lot of candy every day (long-term). Do you think it is good for John to eat a lot candy (today vs. everyday)? Why or why not?). Study 2 had an identical procedure except that mother-child dyads ($n=32$) were presented with a picture book with 4 physically active and 4 sedentary activities and asked if it was good for the character to engage in these activities either on a short or long-term basis (John swam a lot today vs. John swims a lot everyday respectively for the short and long-term conditions). Was it good for John to swim a lot today vs. everyday?) Separate mother-child dyads participated in each of the studies. Conversations for each of the mother-child dyads were audio-taped and transcribed verbatim. The transcripts were checked and coded independently by 3 coders and the kappa was 0.9 for both studies. The results for Study 1 indicated that the short vs. long-term time frame did not have a significant impact. Interestingly the greatest number of utterances was on the detrimental nutritional consequences of eating unhealthy

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foods. Although nutritional consequences were discussed for healthy foods, it was significantly less than what was discussed for unhealthy foods ($M_s = 4.1$ and 2.8 for healthy and unhealthy foods respectively, $p < .01$). Followed by nutritional consequences, physiological consequences were discussed ($M_s = 2.8$ and 2.7 for healthy and unhealthy foods respectively) followed by psychological consequences ($M_s = 1.2$ and 1.9 for unhealthy and healthy foods, $p < .01$). The results for Study 2 indicated that mothers focused on the physical benefits (makes you tired, helps you grow) on engaging in active activities on a short and long-term basis but also focused on the psychological benefits/issues of engaging in physical and sedentary activities on a long term basis ($p < .05$). For example, 'it is fun to swim a lot everyday' or 'playing video games every day will lead to boredom'. These two studies will help bridge the gap between maternal input and preschoolers' conceptual output about the impact of nutrition and activities on wellness.

1-D-79 Children and adults' recognition of the impact of activities on body size

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Two studies examined if preschoolers and adults recognized the association of body size with physical and sedentary activities. Study 1 investigated if preschoolers and adults ($n = 24$ for each age group) associate either a thin or heavy body size to being active or sedentary. Study 2 examined if preschoolers could benefit from being taught the role of activities on body size. In Study 1 adults stated that the thin caricatures engaged in physically active activities whereas in Study 2 they associated engaging in sedentary activities leading to being overweight. Preschoolers across both studies did not recognize the role that activities played on body size. Teaching them did not have a significant effect on their performance. This could be due to the lack of environmental input or the lack of conceptual readiness. These findings highlight the urgent need to emphasize the importance of physical activities in maintaining a healthy lifestyle in early childhood.

1-D-80 Co-occurrence regularities in language shape the development of semantic knowledge

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Our knowledge about the world is represented not merely as a collection of concepts, but as an organized lexico-semantic network of concepts linked by relations, such as association in the environment (e.g., cow and milk), and "taxonomic" membership in the same stable category (e.g., cow and dog). This organization fundamentally facilitates many of the cognitive feats we accomplish every day, including retrieving knowledge from memory, understanding and producing language, reasoning, and integrating new information into existing knowledge. A key facet of understanding how we develop into adults who accomplish these cognitive feats with ease is therefore to understand how we develop organized knowledge networks. The many accounts of knowledge organization development proposed to date have focused almost exclusively on how we develop knowledge of taxonomic relations (Inhelder & Piaget, 1964; Nelson & Lucariello 1992; Gelman & Markman 1986). However, the importance of better understanding the formation of associations is underlined by evidence that association plays a large role in children's knowledge organization Blaye et al., 2006; Fenson et al., 1989; Smiley & Brown, 1979; Tversky, 1985; Walsh et al., 1993) and may continue to do so into adulthood (Lin & Murphy, 2001; Ross & Murphy, 1999). The present research was therefore designed to investigate the contributions to the development of knowledge organization of one potentially powerful driver of the formation of

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associations between concepts: The regularity with which words for concepts reliably co-occur in linguistic input. Moreover, we contrasted these contributions with those of taxonomic relations. In the present experiment, we measured the influence of co-occurrence (determined from corpora of child speech input from CHILDES; MacWhinney, 2000) and taxonomic relations (determined from close similarity in meaning in WordNet; Princeton University, 2010) on knowledge organization across development, in preschool-age children and adults. To facilitate this comparison across disparate age groups, we measured the influence of relations implicitly using a preferential looking paradigm. Specifically, we measured the degree to which hearing a prime word (e.g., milk) prompted participants to preferentially look at a picture of a related concept (e.g., cow) versus a picture of an unrelated concept (e.g., shoe). To gain a fine-grained measure of preferential looking, we examined the time course of looking at the unrelated, co-occurring and taxonomically related item over a 2s trial period (see Figure 1). The results have revealed that adults show similar patterns of preferential looking for co-occurring and taxonomically related items. In contrast, although children were sensitive to both types of relatedness, preferential looking tendency was substantially smaller and tapered off more rapidly for taxonomic versus co-occurring items. These results provide evidence that co-occurrences play an important role in shaping knowledge organization throughout development, and may even exceed the role of taxonomic relatedness in early childhood. By the same token, these results highlight the importance of identifying a key role for co-occurrence regularities in accounts of knowledge organization development.

1-D-81 Expectations about skin color inheritance by American children and adults

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Given America's history of describing multiracialism in fluids terms (e.g., "mixing" or "one-drop"), we asked if American children may learn to use fluid-mixing as a generative analogy for reasoning about racial inheritance. We designed an experiment to characterize predictions about the inheritance of a salient race-linked trait: skin color. To date, 142 children (4.0-11.4 yrs; 13% Black, 16% Multiracial, 67% White) and 58 adults (18-22 yrs; 21% Black, 15% Multiracial, 40% White) have participated. Stimuli were cartoon images of parents and infants (skin condition) or drinks (fluids condition) drawn from a continuous color space. Participants viewed pairs of parents or drinks, including a dyad with one light and one dark parent or drink. Participants were then presented with a series of baby or drink probes of different colors. Both children and adults endorsed more probe shades as possible in the skin than fluids condition (both $p < 0.0005$). More children used fluids (15%) than genetic (2%) terms to explain their judgments ($p = 0.01$). Adults showed an asymmetric pattern of cross-domain explanation, with 24% using fluids terms to explain skin judgments but 0% using genetic terms to explain fluids judgments ($p < 0.0005$). The results demonstrate an early and prolonged tendency to explain the process in terms of fluids but also an early and prolonged appreciation of the randomness of skin color inheritance in the populations tested.

1-D-82 Spatial metaphors facilitate word learning

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Children are excellent word learners. However, learning words that label abstract concepts is hard. One route that may help children circumvent this difficulty is metaphorical extension. Across languages,

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spatial words are commonly used to describe abstract domains, like time or musical pitch. It is likely easier for children to learn the meaning of a word that labels a spatial attribute compared to one that labels a fleeting attribute such as pitch. But, if a child has first learned the spatial meaning of a word, this could help her guess the word's meaning when it is used in abstract contexts. For example, a child could guess that a word that labels high spatial positions is also likely to label high pitches, on the basis of pre-existing associations between pitch and space. To evaluate this proposal, we taught 3- to 5-year-old English-learning children (N=152) a novel adjective in the domain of space or pitch and tested their ability to extend the adjective to the untrained dimension. Children showed an advantage for learning adjectives that apply to space relative to pitch. However, children who successfully learned the adjectives were equally able to extend from space to pitch and vice versa. Metaphor familiarity did not affect children's performance, meaning that children were not relying on their preexisting knowledge of metaphors in English. These results suggest that spatial metaphor facilitates word learning by scaffolding the acquisition of abstract word meaning.

1-D-83 Digital scaffolding: Improving conversation quality during parent-child shared eBook reading

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Previous research shows that in general, families do not naturally use shared book-reading time as an opportunity to actively engage children in learning (Britto, Brooks-Gunn, & Griffin, 2006). The "dialogic reading" intervention trains caregivers to engage in discussion with their children around storybooks (Whitehurst et al., 1988). Parents are taught a Prompt-Evaluate-Expand-Repeat strategy for promoting rich conversation (following the acronym PEER). They are also encouraged to vary the types of questioning prompts they use on different pages, following the acronym CROWD (including Completion prompts, Recall prompts, Open-ended questions, Wh-questions, and Distancing prompts). This method has been shown to promote expressive vocabulary, receptive vocabulary and story comprehension in young children (Strouse et al., 2013; Zevenbergen, & Whitehurst, 2003). However, training parents to use these techniques can be challenging (Mol et al., 2008). To make this method more accessible, we incorporated a dialogic reading-based avatar (Ramone) into an electronic storybook. On every page, after the story narration, Ramone models dialogic-based questioning prompts for caregivers. In a second version of the e-book, Ramone models increasingly more challenging prompts (an important element of dialogic reading), but only appears on 7 of the 12 pages. This design choice gives parents the opportunity to independently generate their own prompts on the remaining 5 pages. Past research revealed significantly more use of CROWD prompts by parents who read the experimental e-book with their children when compared to families who used the basic, narrated e-book without Ramone (Troseth et al., 2019). In the current research, caregivers and their 3- to 4- year old children were randomly assigned to read the storybook two times in one of four formats. One group read the two versions of the experimental e-book with Ramone (N=17 dyads); the other groups read either the same narrated e-book without Ramone (N=16 dyads), the e-book without narration or Ramone (N=16 dyads), or a paper version of the same book (N=17 dyads). To see whether caregivers were actively learning the dialogic techniques from Ramone, we evaluated their conversational structure throughout the reading. Using a dialogic reading-based coding scheme, each caregiver utterance was given a PEER code (indicating parent's spontaneous use of the Prompt-Evaluate-Expand-Repeat strategy). On the five pages without Ramone, any parent questioning prompts were given a CROWD code, indicating parents' independent

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use of the different types of prompts (Completion prompts, Recall prompts, Open-ended questions, Wh-questions, and Distancing prompts). Preliminary analyses indicate that caregivers who used our experimental e-book asked more of their own Open-ended questions than those in the other conditions, $F(3)= 32.59$, $p<.001$, and also asked more Wh-questions, $F(3)= 19.67$, $p<.001$. Further, caregivers who used the experimental eBook produced more Prompts ($M= 48.83$) throughout the entire reading, $F(3)= 12.94$, $p<.001$. They also produced more Evaluations of their child's responses, a key component of the PEER strategy, $F(3)= 6.76$, $p=.001$. This study suggests that e-book technology can be of great use in making dialogic reading-based skills accessible to families, which over time may promote children's language development.

1-D-84 Context effects on 2-year-olds? Category-relevant and category-irrelevant fact learning

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Context affects memory. Similarities between learning and test environments improves memory, whereas dissimilarities reduce memory (Smith, 2013). This may not always be the case, however. Indeed, some types of learning seem impervious to context effects, such as children's word learning (Wojcik, 2017), though context does affect children's fact learning (Tippenhauer & Saylor, 2019). One possibility for this difference is the category relevance of words and facts. Words are relevant to an object's category membership, but certain facts are not. We investigated whether 2-year-olds ($N=48$) demonstrate context-dependent memory when learning category-relevant (e.g., "This kind is used in the kitchen.") and category-irrelevant facts ("The cat stepped on one like this."). Results demonstrated a difference in context-dependencies for different fact types, $F(1, 44)=6.96$, $p=0.01$. For category-irrelevant facts, context effects appeared immediately following training. For category-relevant facts, on the other hand, context effects only emerged after a delay. These results present new insights into what children attend to and potentially encode when learning different kinds of information.

1-D-85 What does decontextualized language look like in the second year of life

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Decontextualized language (DL) to children moves beyond the 'here' and 'now', supporting children's higher-level cognition and language skills. However, studies of DL typically rely on structured tasks such as book-reading; examine preschool- and school-age children; and fail to analyze DL by degrees of separation in time (near present versus past or future) and space (nearby versus distant). We video-recorded and transcribed 36 2-hour home observations, reporting mothers' spontaneous DL input to their 13-, 18-, and 23-month-old infants during everyday activities. Preliminary analyses suggest that mothers increase DL input to their children around 18 months of age ($M=19.2$ utterances, $SD=8.6$), and that DL to 13-month-olds ($M=6$ utterances, $SD=6.9$) occurs primarily during book-reading. DL to 18- and 23-month old infants did not differ ($M=18.6$ utterances, $SD=23.8$). However, ongoing coding will test the hypothesis that DL grows in spatial and temporal 'distance' with child age, even if overall input remains constant.

1-D-86 Children's cognitive reflection predicts conceptual understanding in science and mathematics

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The Cognitive Reflection Test (CRT; Frederick, 2005) is the dominant measure of adult individual differences in analytic vs. intuitive cognitive style. The task was designed to measure a person's tendency to override and inhibit an intuitive response that is incorrect and engage in deliberate reflection that leads to a correct response. The CRT is a meaningful predictor of a diverse range of adult psychological and behavioral outcomes, including conceptual change in science and math learning (Shtulman & McCallum, 2014; Gómez-Chacón et al., 2014). The present research employed a newly developed CRT for children, the CRT-D (Young et al., 2018), to examine the role of cognitive reflection in children's conceptual understanding in science and mathematics. Study 1 investigated whether CRT-D performance predicts conceptual knowledge in the domains of vitalist biology (Zaitchik et al., 2014) and mathematical equivalence (McNeil et al., 2017). Elementary school children (N = 152) completed the CRT-D, which consisted of 9 'brainteaser' questions that elicited intuitive prepotent responses (e.g., "What do cows drink?"). Children also completed 4 executive function measures (NIH Toolbox DCCS, NIH Toolbox Flanker, verbal fluency, backward digit span) and 3 rational thinking measures (denominator neglect, base rate sensitivity, and need of cognition). To measure vitalist biology concepts, we used an abbreviated version of the Vitalist Biology Interview (Zaitchik et al., 2014) that included the Body Parts Interview (e.g., "What are the lungs for?") and the Living Things Judgment task (e.g., "Is a Tree alive?"). Finally, children completed mathematical equivalence problems (e.g., $15 = __ 2$). Regression models found CRT-D predicted children's conceptual knowledge in both domains even after adjusting for age, EF measures, and rational thinking measures. Further, Bayesian model selection suggested CRT-D performance was among the most important variables for out-of-sample predictive performance in both domains. For example, CRT-D was a more informative predictor of children's Living Things Judgments than any other measure. Study 2 investigated whether CRT-D performance predicts children's learning of counterintuitive science concepts. Elementary school children (N = 144) verified, as quickly as possible, statements about life and matter before and after a tutorial on the scientific properties of life or matter. Half the statements were consistent with intuitive theories of the domain (e.g., "frogs reproduce" / "bricks have weight") and half were inconsistent (e.g., "cactuses reproduce" / "air has weight"). Children verified the latter less accurately than the former, both before and after instruction. Instruction did increase children's accuracy for inconsistent statements. Critically, children with higher CRT-D scores showed larger pretest to posttest learning gains, even after adjusting for age and pretest performance. These results demonstrate children's cognitive reflection plays a critical role in conceptual understanding of science and mathematics. Cognitive reflection may facilitate children's online expression of counterintuitive science and math concepts as well as children's learning of such counterintuitive concepts. Broadly, this work suggests children's cognitive reflection has important theoretical and pedagogical implications.

E – Psychological and moral reasoning

1-E-87 **Children hold an intuitive economic theory of diminishing marginal utility**

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People's decisions regarding resource acquisition and valuation have long been explored by economists. Because children participate in economic exchanges themselves, this topic is of increasing interest to

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developmentalists (Echelbarger, Gelman, & Kalish, 2018). Might children's intuitive economic theories align with formal economic principles? Our pre-registered studies test whether children intuitively understand diminishing marginal utility (DMU). DMU states that the more abundant a resource is, the less value we place on each unit. Thus, gains and losses are more meaningful to those with less than those with more. We present 5-8-year-olds with vignettes involving pairs of individuals who start with different resource quantities and then face gains or losses. In Study 1 ($n = 104$), both individuals equally like the resources. We found that children make DMU-like predictions, e.g., predicting that individuals with less will work harder to obtain additional resources than individuals with more ($p < .001$). In Study 2 (ongoing; current $n = 82$), only one individual likes the resources. Children appropriately diverge from Study 1's pattern ($p < .001$), indicating sensitivity to others' preferences and an implicit understanding of DMU's boundary conditions. Even young children hold intuitive theories that license sensible predictions of others' resource valuations.

1-E-88 Choosing selfishly: The development of interpersonal regret in a children's gambling task

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Background We experience regret when we consider 'how things could have turned out differently' and make counterfactual comparisons with an imagined alternative. Because experiencing regret requires the ability to make such evaluative counterfactual comparisons, it is a late developing emotion, emerging at around 5 to 6 years (Burns, Riggs & Beck, 2012). Regret is considered functionally important because of the role it plays in decision-making. It is possible to regret decisions that result in a poor outcome either for ourselves or for others, creating a distinction between intrapersonal and interpersonal regret (Uprichard & McCormack, 2018). To date, regret research has focussed almost exclusively on the former, meaning very little is known about the development of interpersonal regret or its potential corresponding functions. **Method** Sixty 7-8-year-olds and sixty-six 8-9-year-olds participated. Participants were required to choose between two games of chance in order to win a prize for themselves and a peer. Each game contained two possible outcomes for each individual, of which only one each could be obtained. One game contained highly advantageous outcomes for participants, but very poor ones for the peer. Alternatively, children could choose a game that was potentially less advantageous for themselves, but more fair. Participants completed both self- and interpersonal-regret conditions, where they saw that for the target individual, the choice they had made resulted in a very poor outcome. At this point participants reported how they felt using an emotion scale. A counterfactual outcome was then revealed to children, where they saw what the target individual would have received had they made the alternative choice. At this point children were asked, relative to their prior emotional judgment, whether they now felt 'happier, sadder or the same' as before. Those children who rated themselves as feeling sadder after learning the counterfactual were interpreted as demonstrating regret. Of specific interest was whether children experienced regret concerning other children's poor outcomes, where a more positive one could have been obtained. **Results** Children's responses were coded as sadder vs. not sadder. The critical analyses compared the frequency of sadder responses in each trial type against chance. Eight-to-nine-year-olds reported feeling sadder significantly above chance levels in both self-regret ($p < .001$) and interpersonal regret ($p = .015$) trials. Seven-to-eight-year-olds also felt sadder more often than chance in the self-regret condition ($p = .011$), but not the interpersonal condition ($p = .438$). These findings suggest that interpersonal regret may emerge later

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than self-regret. Implications The findings are the first to show interpersonal regret in children in a task of this kind. If regret concerning our own outcomes is adaptive for improved decision making, it is possible that interpersonal regret may play a role in social and moral decisions. Establishing the age at which children experience interpersonal regret provides a starting point for study in this area.

1-E-89 Developmental differences in children's intention attributions of relational and physical transgressors

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Intentions are a meaningful cue used to evaluate transgressions, but are often ambiguous. In such contexts, children make intention inferences through other cues, such as whether an act resulted in damage to relationships or physical harm. To better understand how children process social cues, we assessed the influence of transgression type on intention attributions. With age, social experiences may impact judgments of relational versus physical harm, and improved use of intention cues may implicate judgments made in ambiguous or unambiguous contexts. Five- to 10-year-olds (N=139) heard stories about physical and relational transgressions. Intent was either ambiguous or purposeful (unambiguous). Children evaluated how much each transgressor tried to instigate an outcome. A three-way interaction between age, ambiguity and aggression emerged, $F(1,138)=6.13$, $p=.015$. When unambiguous, more intent was assigned to those who caused physical compared to relational harm. When ambiguous, more intent was attributed to relational rather than physical harmers. With age, these transgressors were seen as more intentional, $t(54.48)=3.96$, $p<.001$ (see Figure 1). Current findings highlight the salience of harm to social relationships in typical scenarios when intent is unknown. With age, harsher judgments of relational transgressors may reflect increased importance of social relationships. As a whole, findings reveal how children process various social cues throughout development to make moral judgments.

1-E-90 Differences in school readiness predictors for dual language learning and monolingual preschoolers: The role of executive functioning, metalinguistic awareness, and theory of mind

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Dual language learners (DLLs) are over 9% of K-12 students in the United States. Given U.S. demographics, most of these children are learning two languages because the home language is not English, making them at-risk for academic achievement (Reardon & Galindo, 2006). Research on monolinguals shows that cognitive factors during preschool predict later academic achievement: language proficiency (Tramontana, Hooper, & Selzer, 1988), executive functioning (EF) (Bull, Espy, & Wiebe, 2008), metalinguistic awareness- which refers to children's understanding of the nature of language (Demont & Gombert, 1996), and theory of mind false belief (FB) reasoning (Lecce, Caputi, & Hughes, 2011). We know this is the case for monolingual children, but we don't know if these same cognitive factors are related to school readiness for DLLs. Aside from language proficiency, these factors related to school readiness have also been found to be enhanced in DLLs: EF (Bialystok & Viswanathan, 2009), FB reasoning (Kovacs, 2009), and metalinguistic awareness (Davidson, Raschke, & Pervez, 2010). Do these school readiness factors help DLL children be better prepared for school? We recruited 71 preschoolers, 49 monolingual English (46 months F=22 M=27), and 22 DLLs learning English at school and another language at home (47 mo. F=11 M=11). Parents filled out questionnaires about language exposure, SES, and family reading habits. The early academic skills subtests of the Woodcock-Johnson

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(WJ) Early Cognitive and Academic Development were used to assess school readiness, and the Core Language subscale from the Clinical Evaluation of Language Fundamentals (CELF, 2004) to assess English language proficiency. EF tasks included a Working Memory backward digit-span task and the inhibitory control Happy/Sad task (Lagattuta, Sayfan, & Monsour, 2011). The Synonym Judgement task (adapted from Doherty & Perner, 1998) was used for metalinguistic awareness. The FB battery included the Unexpected Location task where an object is moved unbeknownst to a character (Wimmer & Perner, 1983), Object Disappearance task where the object disappears instead of being moved (Wellman et al., 2001), and the Bilingual Ice Cream task where a character speaks in a language only one of the other characters understands (Kovacs, 2009). We found that for both DLLs and monolinguals, school readiness (WJ subtests composite) was related to language proficiency (CELF) (DLL $r(18)=.87$, $p=.000$, mono $r(43)=.42$, $p=.005$) and working memory (DLL $r(18)=.63$, $p=.004$, mono $r(43)=.52$, $p=.000$). Interestingly, for DLLs only, the WJ composite was related to FB $r(18)=.57$, $p=.01$, and metalinguistic awareness $r(18)=.53$, $p=.02$. For monolinguals, the same WJ composite was also related to inhibitory control $r(43)=.40$, $p=.007$, SES $r(43)=.33$, $p=.03$, and home reading frequency $r(43)=.39$, $p=.008$. In conclusion, we found notable differences in the factors that DLLs and monolinguals recruited for school readiness. In addition to parallel skills like language proficiency and working memory, DLLs relied more on FB and metalinguistic awareness, while monolinguals relied on more traditional factors like inhibitory control, SES and family literacy habits. These findings highlight the importance of examining relationships for DLLs we take for granted from research on monolinguals, as well as getting away from simple performance comparisons between these groups to explore the significance of cognitive advantages associated with bilingualism.

1-E-91 Making the best of a bad situation: Examining the consequences of explanations highlighting societal inequality

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Incarceration unduly burdens marginalized groups. Yet, people underestimate the extent that societal inequality drives hardship in others' lives. Underestimating societal inequality in incarceration may reflect a bias to attribute outcomes to internal, versus external, causes. This work tested the effects of different attributions for incarceration. In Study 1, 86 6-to-8-year-olds and 123 adults learned about targets incarcerated for internal, behavioral, or societal factors. Subjects then rated attitudes toward each target. Subjects reported the most positivity toward those incarcerated for societal reasons than any other reason ($ps \leq .001$), and more positivity toward those incarcerated for behavioral rather than internal reasons ($ps \leq .002$). Study 2 asked if the negativity from internal explanations could be reduced by concurrently highlighting other explanations. Here, 74 6-to-8-year-olds learned about targets incarcerated for internal factors and one other reason (behavioral, societal). Subjects reported more positivity after hearing explanations referencing internal factors plus a societal factor than after hearing explanations referencing just internal factors ($t(73)=10.19$, $p<.001$). However, we did not find a difference in attitudes after subjects heard about an internal reason alone versus an internal reason plus a behavioral reason ($t(73)=.64$, $p=.523$; Fig. 1). This work highlights the benefits of teaching people about the role of societal factors in incarceration.

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1-E-92 The relationship between metalinguistic awareness and moral development

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The purpose of our study was to examine the relationship between language, Theory of Mind (ToM), and moral development. Prior work has demonstrated a relationship between ToM and language (Milligan, Astington, & Dack, 2007), and ToM and moral development (e.g., Smetana et al., 2012). However, few studies have examined the relationship between language and moral development. We hypothesized that the representational understanding required for metalinguistic awareness (e.g. Doherty & Perner, 1998) would foster more flexible and abstract approaches to moral dilemmas. Thus far, we tested 16 participants, ages 4-7 (mean age 78.4 months, 10 females). We found, interestingly, that higher scores on a symbol substitution task related to seeing moral transgressions as more permissible, after controlling for age and ToM scores ($p < .05$). Symbol substitution requires substituting one word for another while treating the substituted word as the word for which it was substituted (e.g., calling an airplane a turtle, and then saying the turtle can fly). Such flexibility may also lead children to view transgressions as less rigid, compared to children who have more difficulty in symbolic substitutions. This may also contribute to the "U shaped curve" observed in moral development (e.g. Nucci & Turiel, 2009). Our results reflect initial data collection as part of an ongoing, larger study. More data collection will be necessary, but these results hold powerful implications for precursors to important social and emotional developments.

1-E-93 Social evaluation based on group conformity: What can experiences say?

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What are the roles of nature and nurture in human conformity? The present research examined third-party evaluation on conforming and non-conforming characters in human infants with, or without, extensive group experiences. Infants were habituated to videos in which one character always followed others' unanimous action whereas another character consistently acted different from others. Then infants' preference between the two characters was tested in a preferential reaching paradigm. Eight- to twelve-month-old infants ($n = 16$), none of whom had attended childcare institutions (thus little to no group experiences), showed no preference between the conforming and non-conforming characters. Two-year-olds attending childcare institutions ($n = 16$), but not their age mates without experiences in childcare institutions ($n = 16$), preferred the conforming character to the non-conforming one. The results suggest that experiences of group interactions may play a pivotal role in the development of a bias favoring conforming actors.

1-E-94 Children's perception of group membership-based transgressions

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When evaluating transgressions, adults take into consideration the reasons behind the actions. An important distinction is one between group- and person-based reasons: Adults consider transgressions motivated by the victim's group membership ("hate crimes") to be worse than transgressions motivated by personal reasons (e.g., dislike of the victim; Rayburn et al., 2003). While we know that children tend to evaluate outgroup harm as more acceptable than ingroup harm (Rhodes & Chalik, 2013; Mulvey,

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2016), no work has examined how children react to transgressions based on whether they are committed for group- vs. person-based reasons. In the current study, we asked children (N = 65, ages 4-9) and adults (N = 87) to evaluate three different scenarios: 1) a transgression against an outgroup member based on their group membership, 2) a transgression against an outgroup member based on a personal reason, and 3) a transgression against an ingroup member based on a personal reason. We examined participants' perceptions of these scenarios with a range of measures (e.g., how bad the action was, how punishable it was, how bad the transgressor was as a person). Overall, children rated the transgression against an outgroup member that was motivated by their group membership as least serious, while adults tended to rate it as most serious.

1-E-95 Liking and caring: Children distinguish between different forms of regard for objects

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People can have different forms of regard for objects, such as liking and caring about them. However, these feelings do not always align. For instance, you might like someone else's new bicycle over your own because it looks nicer, but you may care more about your bicycle simply because it is yours. In two experiments (N=409) we examined how ownership and physical features influence which objects are preferred and cared for. Experiment 1 examined children's own regard for objects when their property was less attractive than someone else's. Children aged 3-6 were more likely to indicate their own property when asked which object they cared about than when asked which object they liked, $p < .001$, with older children being more likely than younger children to differentiate between these two forms of regard, $p = .038$. Experiment 2 investigated children's inferences of which objects others care about and like. We again tested children aged 3-6, and observed similar results: Children inferred that owners care about their own objects than more attractive objects belonging to others, despite believing that the more attractive objects were preferred, $p = .002$. The findings also revealed that children's judgments of which objects people care for did not change with age, $p = .907$, but their preferences judgments did, $p = .001$. Together, these findings show that young children distinguish between different forms of regard for objects.

1-E-96 The role of anthropocentric informational assumptions in moral evaluations about environmental transgressions

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The current environmental crisis has motivated the emergence of new education programs. However, there is growing concern that most of these initiatives are still anthropocentric and prioritize human economic interests, instead of the intrinsic value of nature (Kopnina, 2012). Despite this, research is lacking on how anthropocentric cultural assumptions influence children's moral evaluations about environmental damage and how this might change over development. To address this gap, in this study, third graders, seventh graders and undergraduate students (N = 96) from Colombia were interviewed about animal mistreatment and energy waste before and after being told an anthropocentric informational assumption. Results showed that participants' attitudes to environmental transgressions changed after hearing anthropocentric assumptions. They were more accepting of both transgressions at post-test than at pre-test, $p < .001$. This was also reflected in their judgement justifications: At pre-test, participants were more likely to biocentrically comment on the intrinsic value of nature/animals, p

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<.001. However, at post-test they prioritized human considerations, $p < .001$. A developmental difference was also found. At post-test, undergraduates were more accepting of environmental transgressions than third graders at the post-test, $p < .01$, suggesting that anthropocentrism increases over development. In conclusion, children and adults are highly influenced by anthropocentric assumptions, which increases rather than decreases their acceptance of environmental transgressions. This information is highly relevant when considering the design of environmental education programs.

1-E-97 Children's and adults' evaluations of science resource inequalities

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With age, children evaluate resource inequalities negatively, such as unequal access to medical supplies, and take previous disadvantaged status into account when making these judgments. Surprisingly, little is known regarding how children evaluate resource inequalities when prior disadvantaged status is related to stereotypes, such as those that exist regarding gender inequalities within STEM and science contexts. Children (5-6 year-olds and 9-11 year-olds) and adults ($N = 144$) evaluated science resource inequalities for groups of boys and girls, varying two indices: 1) high or low effort at science, and 2) prior advantaged or disadvantaged access to science materials. Participants found the inequality more acceptable when the high effort group was advantaged compared to disadvantaged ($p < 0.05$). With age, 9-11 year-olds and adults evaluated resource inequality most positively when girls were the high effort group and had more resources, and more so than did 5-6 year-olds ($ps < 0.05$), indicating that the gender of the recipient group was considered relevant, with age. Participants evaluated perpetuating the inequality as okay, and evaluated rectifying the resource inequality as least okay, when girls were the high effort and advantaged group ($ps < 0.05$). These findings reveal that children and adults recognize that resource inequalities generated by the merit of an advantaged group are legitimate, but also consider merit when girls are advantaged more than when boys are advantaged. Thus, the current study provides novel insights regarding developmental evaluations of inequality and STEM-related concepts as they pertain to gender group membership.

1-E-98 How do they feel?: Preschoolers represent false beliefs about emotions

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Hundreds of studies highlight the ability to track others' beliefs as critical to navigating social interactions. Yet, nearly all extant belief tracking studies measure children's ability to represent beliefs about object locations or properties, leaving the scope of early false belief representations unclear. Can children represent false beliefs about other aspects of the world? Here we tested children's ability to track an agent's belief about an emotional state. Children heard 2 stories in a modified Sally-Anne task; one involved a false belief about an agent's emotion, and the other about an object's location. In the Emotion story, children met 2 characters who partook in an event (getting ice cream or playing catch), making both characters happy together. Then one of the characters left. The remaining character then experienced an event eliciting an emotional response that contradicted how they had originally felt (e.g., they dropped their ice cream or lost their ball). Children were probed on what the character who had departed early believed the remaining character to be feeling. We found that 3- to 5-year-old children represented a false belief about an emotional state just as accurately as they represented a false belief about an object's location. Further, the ability to track false beliefs about objects and

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emotions increased with age (Figure 1). These findings suggest that once children can represent false beliefs, they can do so about a range of content.

1-E-99 Precise prosociality: How children's number cognition predicts exactness in sharing vs helping contexts

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Young children act prosocially in ways that range from helping others attain their goals to sharing costly resources. Over the last decade, a number of researchers have differentiated between varieties of prosocial behavior based on the underlying cognitive requirements. Proposing, for example, that goal attribution underlies helping whereas sharing should rely more heavily on number cognition and effortful control. Importantly, experimental examinations of these proposals have lagged behind. Inspired by prior research finding that children's developing numerical cognition explains their sharing behavior, the present study investigated how number cognition affects two forms of prosocial behavior: sharing and helping. Thirty children (data collection ongoing; pre-registered N = 80), aged 3-6 years old, were given the opportunity to display instrumental helping and sharing. In both tasks, children were presented with 10 stickers, and a puppet that either also liked the stickers (sharing task) or needed 5 of them to complete a puzzle (instrumental helping task). Afterwards, children's counting skills were also assessed using a Give-N task. Despite of the fact that both tasks followed a highly similar format, utilized the same resource, and had an implicit social norm of giving half (5 stickers), children's counting skills predicted exactness (giving 5 stickers) in the sharing, but not the helping task. Counting proficiency explained age-related changes in sharing equally. Most children, regardless of counting proficiency, helped by approximating the number of stickers the puppet needed. Results suggest a unique relationship between counting skills and appropriate sharing.

1-E-100 Infants' eye-movement and pupillary responses to sociomoral scenarios

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The current study used eye-tracking technology to explore how infants process sociomoral scenarios. We presented children with the "Hill" scenario in which a protagonist repeatedly tried but failed to reach the top of a steep hill. On his third attempt, the protagonist was assisted (pushed up the hill) or hindered (pushed down the hill) by other characters. Past research using this scenario has found that infants preferred to touch (Hamlin et al., 2007) and looked longer at (Hamlin et al., 2010) helpful over unhelpful characters, suggesting that infants more positively evaluate the prosocial (vs antisocial) characters. However, it remains unclear whether infants' social preferences are related to their cognitive and emotional responses to the scenario. The current study assessed eye-movement and pupillary responses to the Hill scenario in infants aged 5 months, 18 months, and 24 months, to explore 1) how infants distribute visual attention when viewing the Hill scenario, 2) whether prosocial/antisocial events elicit changes in sympathetic arousal, 3) whether visual attention and arousal predict infants' social preferences, and 4) whether there are age-related changes in infants' cognitive and emotional responses to the Hill scenario. Results provide insights into how sociomoral scenarios are processed by infants, and shed light on the links between infants' cognitive and emotional responses to sociomoral scenarios and their social preferences.

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1-E-101 Dissociating theory of mind and mind-mindedness in middle childhood and adulthood

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Individuals vary in the tendency to treat others as though they are independent mental entities (i.e., mind-mindedness [MM]). Extensive research has examined whether parents' MM predicts children's theory of mind (ToM), but less is known about how MM in other contexts relates to social cognition. To better understand the development and corollaries of MM, school-aged children (n=53, 7-12y) and adults (n=111, 18-30y) completed two MM assessments (describing a close and a distant social partner) and a battery of spontaneous and explicit ToM tasks. Given theorized links between social cognition and social anxiety, we also assessed anxiety traits. Adults were significantly more mind-minded than children when describing a close partner (i.e., a higher percentage of their statements dealt with mental attributes; 33% vs. 14%, $t(158)=5.64$, $p<.001$), but there were no age differences for the distant partner (15% vs. 14%, $t(156)=.06$, ns). We did not find evidence for relations between ToM and MM, as no ToM measure significantly correlated with MM in adults or children. Further attesting to this dissociation, MM toward a close partner was positively related to social anxiety in both adults ($r=.22$, $p=.02$) and children ($r=.45$, $p<.01$), but no ToM measure related to social anxiety. Our results add to literature suggesting that MM is dissociable from other social-cognitive constructs and might uniquely relate to social functioning throughout development even outside of parent-child contexts.

F – Social cognition and social learning

1-F-102 Read to me: Prerecorded, video chat, and in-person reading are related to similar vocabulary and comprehension outcomes in preschoolers

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If children can learn new vocabulary from video chats (Roseberry et al., 2013), perhaps they can also profit from being read to over video chat. Four-year-olds (N= 53) were randomly assigned to one of three conditions using The Busy Beaver book. In the prerecorded condition, children viewed a video of an experimenter reading the book. In the video chat condition, the same experimenter read to children over video chat. In the live condition, the same experimenter read the book to children in person. Only the last two conditions contained contingency, as the experimenter responded in a timely, relevant manner to children's behaviors. After reading, children completed near and far transfer assessments of vocabulary words, a reading comprehension measure, and a page-by-page retell task. A three-way ANOVA compared performance on the retell task across conditions. Three independent Kruskal-Wallis tests were also conducted to compare scores for near transfer, far transfer, and comprehension across conditions. No condition differences were found for any of the tasks (retell: $p = .393$, near transfer: $p = .434$, far transfer: $p = .343$, comprehension: $p = .936$). Four-year-olds may learn similarly from prerecorded, video chat, and live reading activities, suggesting new opportunities for reading with children.

1-F-103 Environmental instability promotes social cognitive development in infant rhesus monkeys (Macaca mulatta)

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Despite a global increase in environmental instability, we know relatively little about the ways in which human cognitive development responds to unpredictable conditions. To understand how the experience of environmental unpredictability shapes developmental processes, we examined a non-human primate model of cognitive development that better accounts for confounding demographic factors that can also impact human development (e.g., access to health care, nutrition, or SES). Specifically, we tested social cognition in a population of infant rhesus monkeys (*Macaca mulatta*) living at Cayo Santiago in Puerto Rico. Monkeys in this population recently faced a period of environmental instability when Hurricane Maria destroyed much of the island's food supply. In the present study we tested $n=57$ infant rhesus monkeys on a gaze following task assessing social attention. Monkey performance on this task has a pre-established developmental trajectory, so we could compare these infants' performance to a cohort of $n=52$ infants born before the storm who experienced more stable environmental conditions. We found that infants born after the storm show marked improvement in performance in a gaze following task, gaze following significantly more than infant who did not experience the storm (0.32 versus 0.01 seconds; $t(158) = -4.94$, $p < 0.001$). These results suggest that environmental instability can promote the development of robust social attention in this species. Future work will track whether these differences are stable and attenuating throughout the life course, as well as whether infants with unstable early life experiences have only temporarily enhanced social abilities.

1-F-104 How do conflict and perspective affect children's future thinking?

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In some studies, children and adults have been found to reason better about another person's future than about their own. This may be because we experience less "present-future" conflict when mentally transitioning between another's present and future states as compared to transitioning between our own present and future states. To explore this hypothesis, we gave 112 preschoolers four future thinking tasks (including predicting future preferences and delay of gratification) with two between-subjects factors: conflict (high; low) and perspective (answering for self; answering for other). The high-conflict condition entailed a high level of conflict between what is desirable now and what is desirable in the future, whereas the low-conflict condition entailed much less. We predicted significant main effects of conflict and also conflict x perspective interactions, such that adopting the perspective of "other" would be most beneficial in the high- (but not low-) conflict condition. Although conflict was indeed significant for three of the four tasks ($ps < .03$), conflict and perspective did not interact on any of the tasks (but was in the expected direction for two of the four tasks). We discuss directions for future research as well as implications for contexts that help and hinder children's future-oriented reasoning.

1-F-105 Do demand characteristics contribute to minimal ingroup bias?

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The "minimal group paradigm" is commonly used to explore the consequences of mere membership in novel, arbitrary social categories. Numerous studies have found that young children show bias toward minimal ingroups. An underlying assumption is that children demonstrate ingroup bias specifically

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because of mere membership in the relevant group. However, it is possible that the design of minimal group studies incorporates demand characteristics that lead participants to favor ingroup members. In child minimal group studies, participants are often first assigned to a color-based group. Followup measures determine whether they prefer people wearing the same color as themselves to people wearing a different color. Such designs could communicate implicit expectations to participants by introducing a salient color that is meaningful in the context of the study, and thus inviting them to prefer color-match individuals. Color-match bias, therefore, could be due in part to the presence of demand characteristics, rather than to true ingroup bias. In a preregistered study, we asked whether demand characteristics may contribute to the appearance of ingroup bias in the minimal group paradigm. Child participants ($N = 160$, $M = 5.4$ years, range 4.5 to 6.7 years) were randomly assigned to one of two main conditions. The "group" condition used a typical minimal group manipulation (adapted from Dunham, Baron, & Carey, 2011). Group condition participants were first assigned to a green or orange group, and then completed three measures of bias (Explicit Attitudes, Behavioral Attributions, and Expectations of Reciprocity) by answering questions about their preferences for various children wearing green and orange (displayed in photos). The "no-group" condition retained the potential demand characteristics of the paradigm (through the introduction of a salient colored object) but did not include group assignment. No-group condition participants were assigned a green or orange box using procedures and language closely matched to the group condition (but with no mention of groups). If preferences for color-match individuals (photos of children wearing the color that the participant was assigned) emerged in the no-group condition, it would suggest that demand characteristics embedded in minimal group studies can contribute to the appearance of ingroup bias. However, if preferences for color-match individuals emerged in only the group condition, it would suggest that color-match bias truly indicates the presence of minimal ingroup bias, and does not result in part from the influence of demand characteristics. Three main findings emerged. First, in this well-powered preregistered study, we found no evidence of ingroup bias for two measures in the group condition. Children's choices were consistent with minimal ingroup bias for only one measure, Expectations of Reciprocity. Second, the photos used in this measure depicted children that varied in race/ethnicity across trials, yet participants still showed preferences for their minimal ingroup. Third, although participants in the group condition preferred their minimal ingroup for Expectations of Reciprocity, those in the no-group condition did not demonstrate a color-match bias for this measure. This finding supports the widely held view that mere membership in a group can lead to ingroup bias, and suggests that demand characteristics do not lead participants to prefer color-match individuals.

1-F-106 Non-random acts of kindness: New evidence that joint music making increases prosocial behavior in preschoolers

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Research has shown that active musical engagement promotes prosocial behavior in preschool-age children under some conditions but not others (Kirschner & Ilari, 2014; Kirschner & Tomasello, 2010). The current study consists of two experiments designed to examine preschool-age children's helping and sharing behavior toward a previously unfamiliar adult subsequent to joint musical or nonmusical play. Experiment 1 established a paradigm for comparing sharing and helping after a brief experimental interaction, while also investigating the impact of verbal content on behavior across conditions ($n = 62$, $Mage = 4;8$). Experiment 2 investigated children's sharing and helping subsequent to a joint singing

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interaction that was either temporally regular or temporally irregular ($n = 32$, $Mage = 4;7$). Behavioral coding from video was used in both experiments to explore how the type of interaction impacted children's joint movement, interpersonal movement synchrony, and social engagement throughout the interaction. Results of Experiment 1 showed that musical play was associated with more spontaneous helping ($p = .047$) and overall sharing ($p = .049$) than nonmusical play. Analysis of synchrony and joint movement within the experimental interaction showed that musical play resulted in significantly more joint movement ($p < .01$) and interpersonal synchrony ($p < .01$) than nonmusical play, but that even in musical conditions, joint movement was only perceptibly synchronized for a fraction of the length of the interaction (approximately 27%). There was no evidence of an effect of verbal content on children's behavior, despite uniformly high retention for the content of the song or poem across conditions. Experiment 2 showed that children's sharing, helping, and engagement did not differ following temporally regular or irregular joint singing. A comparison of Experiments 1 and 2 ($N = 94$) indicated that only joint musical play - inclusive of both joint singing and percussive gross motor movement to a regular beat - influenced children's subsequent prosocial behaviors relative to nonmusical play, while joint singing in particular (both temporally regular and temporally irregular) increased children's looking behavior toward a social partner. These findings provide further evidence that active music making can facilitate social engagement and prosocial behavior in preschoolers, regardless of lyrical content, and suggest that joint movement may play a more significant role than precise movement synchrony in preschoolers' musical engagement.

1-F-107 The evolutionary origins of natural pedagogy: rhesus monkeys preferentially use non-social cues versus communicative signals

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The natural pedagogy hypothesis proposes that infants preferentially attend to communicative signals, facilitating rapid cultural learning. This sensitivity is thought to be a uniquely-human cognitive adaptation that is absent in nonhumans. We tested this comparative prediction by assessing $n=208$ rhesus monkeys ranging from infancy to adulthood. Using an expectancy looking time task modeled on prior work with human infants, monkeys saw a demonstrator either make eye contact and vocalize (social cue), or wave a salient fruit and produce a mechanical sound (nonsocial cue). She then either looked at an object (referential look) or looked towards an empty space (look away). We found that, unlike human infants in similar contexts, monkeys looked longer following non-social cues regardless of the actor's looking behavior ($X^2=7.11$, $df=2$, $p=0.03$). Younger and older monkeys also showed similar responses. These results highlight evolutionary changes in human sensitivity to communicative social signals compared to other primates.

1-F-108 Altruistic expectations: How parents shape child cooperative ability

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Children begin to coordinate their actions with others early in life. Although parent factors are frequently cited as a driving force of child development, little is known regarding how parents' values shape their children's early cooperative development. Our study ($N = 239$) examines if parents who cite altruistic reasons as a motive to cooperate rather than egoistical reasons have infants ($Mage = 14.30$, $SDage = .63$) who are more likely to demonstrate greater cooperative abilities in novel tasks with an

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unfamiliar adult experimenter. Parents who cited altruistic reasons had children who demonstrated more coordination ($F(1,126) = 7.44$, $\beta = .22$, $p = .01$, $R^2 = .06$) and success ($F(1,127) = 8.62$, $\beta = .12$, $p < .01$, $R^2 = .06$), but took longer to complete the shared goal ($F(2,123) = 3.59$, $\beta = 1.14$, $p = .02$, $R^2 = .06$) on a complementary roles cooperative task. This is the first known evidence that the reasons why parents think children should cooperate shapes cooperation development in infancy. Possible mechanisms of this association will be discussed.

1-F-109 The development of children's awareness of racial bias in school leadership positions

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Children participate in leadership roles in school settings from an early age. The selection criteria for such positions vary greatly and often reflect biases regarding who is chosen. There is almost no research investigating how children evaluate leadership selections in classrooms. In the present research, 8-14 year-old children ($N=263$) read a vignette in which a teacher selected four students for leadership roles. The vignette varied between-subjects whether the teacher selected students from only one racial group (i.e., either the teacher chose only White, or only non-White students) or selected both White and non-White students equally. Participants evaluated the acceptability of the teacher's selections on a 6-point Likert scale and explained why they thought teachers made their selections. Analyses of children's evaluations revealed an interaction between participant age and condition ($p=.015$) driven by more positive ratings from younger vs. older children in the non-White condition ($p=.004$; other conditions did not differ). An analysis of children's explanations showed that older children were more likely than younger children to indicate that students were chosen because of their race or teacher preference ($ps<.005$). These results show that, with age, children become aware of the potential for bias to exist regarding classroom leadership selections. Yet their evaluations of biased selections only become more negative with age for low-status (but not high-status) groups.

1-F-110 Social networks and neighborhood demographics: Different dimensions of diversity in children's early social experience

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Exposure to racial and linguistic diversity affects children's social cognition. However, past research has not been uniform in how they assess diversity in early social experience: Some ask about a child's "typical" daily experience whereas others use neighborhood demographics to assess exposure to different languages and races. It is an open question whether diversity in daily experience and neighborhood diversity are related to each other. Prior works treat these dimensions as the same, yet it is possible that diversity at the neighborhood level is different from diversity at the daily experience level. To better quantify early social experience, we developed the Social Network Questionnaire (SNQ). SNQ assesses the people a child interacts with on a regular basis and collects their demographic information (i.e., race and the number of languages they speak) to quantify a child's social network. Zip codes are collected to extract neighborhood demographics. For 98 20-month-old and 52 3-year-old children, there were no relations between network and neighborhood linguistic diversity or racial diversity ($r_s < 0.04$; $ps = n/s$), suggesting that network and neighborhood characteristics explain different variations in social cognitive ability. In fact, in another study we find that 3-year-old network linguistic diversity and neighborhood linguistic diversity are independently related to perspective-taking, but

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these factors are not related to each other. We are currently using the SNQ to determine how racial diversity at the network and neighborhood level influence children's racial preferences.

1-F-111 Let questions be your guide? The impact of pedagogical questions on children's STEM task performance

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Adult pedagogical demonstrations can constrain children's learning in exploratory contexts (Bonawitz et al., 2011); by contrast pedagogical questions (PQ)-- a learning partner asking questions with implied pedagogical rather than information-seeking intent -- can provide guidance without imposing constraints (Yu et al., 2018). We investigated whether pedagogical questions also facilitate children's learning during STEM-based problem solving. We presented 159 4-6-year-old children with STEM-based problem-solving tasks in three conditions: without PQ (baseline), PQ prior to task engagement (pre-task), and PQ after initial exploration (post-exploration). Mixed-effects binary logistic regressions revealed that task difficulty (hard vs. moderate; $B = -0.77$, $p < 0.001$) and child age ($B = 1.16$, $p < 0.001$) but not PQ timing ($ps > 0.05$) predicted children's likelihood of solving the task (solve rates depicted in Figure 1). These results suggest that PQ may not always be beneficial for helping children discover solutions to STEM-based tasks. We will discuss implications for these findings for understanding the impact of adult guidance on children's performance in problem-solving contexts.

1-F-112 'Tamanduas are smellier than a skunk!': Children's learning preferences and memory in a natural science center

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Children recognize relevant expertise by age 4 (Lutz & Keil, 2002). In some contexts, children are also sensitive to the valence of informant testimony: 6- to 7-year-olds endorse positive testimony from a layperson at the expense of expertise when learning about novel animals (Boseovski & Thurman, 2014). It is unclear whether this preference for positivity (Boseovski, 2010) may influence children's memory for facts learned in naturalistic settings. The current study explored this question in a museum setting by presenting 80 4- to 8-year-olds with two informants, a zookeeper and a maternal figure, that provided nine conflicting facts (3 positive, 3 negative, 3 neutral) about an unfamiliar animal. We asked children to select which facts they endorsed as correct and assessed children's memory for the information. Irrespective of age and expertise, children endorsed positive facts as correct over neutral facts, $t(79)=2.62$, $p=.01$, or negative facts $t(79)=2.71$, $p=.01$. Six- to 8-year-olds endorsed the facts presented by the zookeeper as correct significantly above chance, $t(48)=2.23$, $p=.03$. Children remembered more neutral than negative, $t(79)=4.48$, $p<.01$, or positive facts, $t(79)=5.32$, $p<.01$, regardless of informant status, $F(1,76)=0.37$, $p=.54$. These results suggest there is dissociation between children's preferences for learning novel information in the moment and what information is remembered, which has implications for educational settings and other learning environments.

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1-F-113 The impact of illusory control on children's request for help

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Research on children's social learning has demonstrated that children learn preferentially from some individuals over others. However, children often choose between using social sources or relying on their own knowledge. This study investigated children's illusory control (children's high confidence in their knowledge) and its influence on their decision to seek help. Children's (3-8 years-old) illusory control was manipulated through levels of success at a game of chance. Subsequently, children chose between answering novel questions by themselves or with help from a knowledgeable individual. Results (N=48) revealed no significant effect of age or illusory control on the number of times children asked for help. Children asked for more help on questions involving novel labels and facts in comparison to questions of chance or individuals' preferences (all p s $\leq .040$). Further investigation is needed to understand in which situations children prefer to rely on information coming from others.

1-F-114 Does power trump reasoning? Understanding the effect of culture on children's trust preferences

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Children use both social cues and epistemic cues to evaluation information. The current study explores cross-cultural comparison on Caucasian-American and Chinese-American children's relative weighing of two factors that are pitted together: social dominance and epistemic competence. 42 5- to 8-year-old Chinese-American children (Mage = 6;11 years, SD = 1.08) and 40 age-matched Caucasian-American children (Mage = 6;4 months, SD = 1.01) were firstly presented with a dominant and a subordinate puppet whose status were built through a decision-making scenario. Children were then asked to choose between the two puppets' differing explanations on familiar phenomena, when the dominant puppet always provided a circular argument whereas the subordinate puppet always provided a noncircular argument. Lastly children were asked to choose between the puppets' explanations on novel objects with comparable quality, i.e., both circular explanations. Results showed that with age, children from both cultures increasingly weighed epistemic competence more than the informant's social dominant status when presented with familiar phenomena, $F_{age(1,79)}=7.18$, $p<.05$, $\eta^2=.11$. Furthermore, Caucasian Americans generalized their preference of the epistemic cue to the novel explanation phase whereas Chinese Americans did not, $F_{culture(1,79)}=4.65$, $p<.05$, $\eta^2=.08$ (see figures). The implications of the cultural differences in children's weighing of social and epistemic cues will be discussed.

1-F-115 Exploring executive function skills and emotion knowledge in low income children using latent growth curve modeling

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Theories of young children's early social cognition suggest that strong self-regulation and emotion knowledge aids children in achieving their goals in specific contexts, including the transition into formal schooling (Denham et al., 2014; Payton et al., 2000; Rose-Krasnor, 1997). Children who are from low-income families often have delays in developing these skills in comparison to their peers, which may put

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them at risk for poorer outcomes (Barnett et al., 2008; Belsky et al., 2007; Vandell, 2004; Yang et al., 2018). The present study aims to expand upon previous research by looking at a low-income population using latent growth curve modeling to examine the developmental trajectories of these skills and their interaction to determine directionality and causality. This will be one of the first studies to examine the interaction of these growth curves in an at-risk sample. Approximately 500 Head Start preschoolers were assessed at 4 time points from ages 4-7 on executive function (EF) skills, emotion knowledge, and vocabulary. Preliminary analyses indicate that the skills at each time point are correlated, but have different growth trajectories (see Figures 1a-1c). The full growth models are forthcoming, and will have important implications to better clarify the causal relationship between the growth trajectories of EF skills and emotion knowledge in this at-risk population.

1-F-116 Preschool-aged children generalize statistically learned functions and labels but not preferences to other agents

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Children use statistical regularities to learn about linguistic and non-linguistic conventions (i.e. words and object properties, Xu & Tenenbaum, 2007; Waismeyer et al., 2015) and expect these conventions to be shared across individuals (Henderson & Graham, 2005; Wohlgelernter et al., 2010). Children also use statistical regularities to learn about preferences (Kushnir et al., 2010). Here we examine whether children generalize preferences of one agent, learned via statistical evidence, to another agent, and how this contrasts with generalization of object functions and labels. Three to five-year-old US children (current N=50, M=4.06, Range=3) saw a puppet select toys that he likes (preference), what makes a toy light up (function), or what things are called (label) out of a box that contained a minority (20%) or majority (80%) of objects of the target type. Preliminary results suggest that children don't generalize preferences ($\chi^2=5.531$, $p=.767$) as they do functions ($\chi^2=52.85$, $p<.001$) and label ($\chi^2=65.43$, $p<.001$), regardless of the box's statistics (see Figure 1). Study 2 will examine effects of culture on children's preference generalization. Data collection is ongoing in Shang-Hai.

1-F-117 You sound like you know, but did you check? Children's evaluations of other's calibrated evidence-based claims

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Children show remarkable capacities to navigate and draw inferences about complicated causal systems, to isolate variables in order to determine causal functions, and to evaluate claims as more or less well-supported by sufficient evidence (e.g., Gopnik, 2012; Schulz, 2012). Although much of this work has established that children can engage in behaviors that yield causal claims, only more recent work (e.g., Butler, Schmidt, Tavassolie, & Gibbs, 2018) has examined how children evaluate others' claims about causal evidence as more or less valid. We examine whether preschoolers can make judgments about whether others' generalized and specific claims are supported, depending on how well-calibrated they are with an evidence set. Findings suggest children systematically prefer informants who have more evidence in support of generically-presented claims (study 1), but struggle when those claims are inconsistently calibrated with the evidence that they check, with improvements between 4-5 and 6 years of age (study 2).

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1-F-118 "Because he said yes right away!": Children use others' decision time when trading to make inferences about their preferences

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How long people take to make a decision gives important insight into how they think--quick decisions indicate little conflict about the decision, whereas slow decisions suggest inner conflict (e.g., Critcher, Inbar, & Pizarro, 2013). Indeed, imagine someone is offered a trade and accepts quickly or slowly; in which case do you think this person liked the item she accepted more? As an adult, you might infer a stronger preference when an item is accepted quickly because this signals little (if any) conflict about the decision. Here we explore if and when 4- to 9-year-olds ($N = 73$, data collection is ongoing) use decision time to make inferences about others' preferences. To do so, we told children about two kids who were each offered a trade: a yellow car for a green car. In both conditions, one character acted quickly and the other acted slowly. Between conditions, we varied whether both kids accepted or rejected the trade. Children were asked which kid liked the yellow car (the item they were offered) more. We predicted and found that children inferred that someone who accepts quickly likes the yellow car more than someone who accepts slowly (68%; $p = .03$). Further, this is not because children generally think that quicker actors like objects more: they did not predict that those who reject quickly like the offered object more than those who reject slowly, $p = .37$. These preliminary results suggest that children use decision time to make inferences about others' preferences.

1-F-119 Metaphorical propaganda shapes children's explicit, but not implicit, attitudes toward novel immigrant groups

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Throughout history, propaganda has leveraged themes of dirtiness and disease to foster negative attitudes toward marginalized social groups (Speltini & Passini, 2014). As children rapidly form attitudes about novel social groups (e.g., Dunham et al., 2011), we investigated whether 5- to 9-year-olds' judgments of foreign ethnic groups could be swayed by visually depicting the groups as dirty (in one of three ways) in poster-sized illustrations, even when photographs indicated that individual members of these groups were not actually unclean. Results indicated that participants ($N = 48$) explicitly attributed fewer positive traits and more negative traits to members of novel groups that were portrayed as "dirty" as compared to "clean" ($p = .029$), an effect that remained stable across age ($p = .203$). They were also marginally more likely to blatantly dehumanize members of the "dirty" group by equating them with ape-like hominids ($p = .060$), but this effect was only evident when the group was portrayed as harboring contagious germs, $p = .005$, as opposed to being unclean in other ways. This effect also increased with age, $p = .016$. Explicit behaviors in a resource distribution task and implicit forms of bias as measured by other tasks did not yield significant results ($ps > .20$). Overall, results indicated that children can rapidly internalize prejudicial attitudes toward novel groups from briefly presented propaganda. However, this effect only occurred for explicit attitudes and not for other forms of bias.

1-F-120 The effects of inter- and intra-group social comparisons on self-evaluations in middle childhood

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Social comparison has a deep impact on children's developing self-evaluations beginning in middle childhood (Ruble, Boggiano, Feldman, & Loeb, 1980). Yet, a growing body of research suggests that comparative feedback is interpreted within the context of peer characteristics (e.g., peer expertise; Lapan & Boseovski, 2017). Peer characteristics that are typically essentialized (i.e., perceived to be inherent and unmalleable) seem to be particularly important, as they increase children's perceptions that peer performance differences are due to inherent differences in ability (e.g., gender, Rhodes & Brickman; traits, Lapan & Boseovski, 2017). The current study examined whether peer race, a salient and often essentialized characteristic (Mandalaywala, & Amodio, & Rhodes, 2017), moderated the impact of comparative feedback on children's self-evaluations. One hundred and ten 7- to 9-year-olds ($M=8.4$), completed an academic assessment of math and science concepts taken from the state exam archives. Children then evaluated their performance on an 8-item self-evaluation pretest (adapted from Rosenberg, 1965). Items assessed children's thoughts about their performance (e.g., "On the whole, I am satisfied with my performance."). Next children were presented with an image of a peer (matched for gender and age) and informed that the child in the photo had outperformed them on the academic assessment. Half of the participants saw ethnic in-group peers, while the other half saw ethnic out-group peers. Finally, participants completed the self-evaluation post-test. Data were analyzed using a Mixed ANOVA with age (7-year-olds, 8-year-olds, 9-year-olds), condition (in-group vs. out-group), participant ethnicity (African American, Caucasian, Asian Pacific Islander, & Latinx), and participant gender (male, female) as between-subjects factors. Trial (pretest vs post-test) was entered as a within-subjects factor. A significant main effect of trial demonstrated that children evaluated their performance more negatively after receiving comparative feedback, $F(1, 66)=1776.09$, $p<.001$, $\eta^2=.96$. This was qualified by a significant trial by condition interaction, $F(1, 66)=90.96$, $p<.001$, $\eta^2=.58$. Follow-up test indicated that pre-test scores did not vary by condition, $t(108)=-0.10$, $p=.91$. Conversely, participants' post-test self-evaluations were significantly lower following out-group comparison ($M=15.96$, $SD=1.83$) as compared to in-group comparisons ($M=21.06$, $SD=1.82$), $t(108)=14.56$, $p<.001$, $d=.79$. There were no other significant effects. Overall, the results demonstrate that social comparative feedback has a significant effect on self-evaluations in middle childhood, and that the ethnicity of comparison peers is a critical factor in determining the magnitude of such effects. The findings further support the idea that highly essentialized person characteristics moderate the impact of social comparison. Given the pervasiveness of social comparative feedback, it is of great importance for future research to examine how to mitigate exaggerated impacts of social comparison based on academically irrelevant characteristics, such as race. One fruitful possibility is to examine how mindset interventions (Sisk, Burgoyne, Sun, Butler, & Macnamara, 2018) may reduce essentialist reasoning and thereby the exaggerated effects of inter-group comparisons.

1-F-121 Passing the epistemic buck: Children's evaluations of errors based on first- and second-hand information

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Preschoolers demonstrate the ability to monitor a speaker's reliability, but they are more forgiving of a speaker's inaccuracy under certain situational conditions (Koenig, Tiberius, & Hamline, 2019). We investigated one key situation, common in testimonial learning, in which the claims of one "speaker" can be traced back a second speaker's (e.g., "helper") claim. Four-year-old children in China ($N=60$) and the United States ($N=35$, data collection ongoing) were familiarized to trials in which the speaker either

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misnamed objects independently (the unassisted condition) or after hearing inaccurate information from the helper (the assisted condition). Children's evaluation of the responsibility for the mistakes revealed a condition (assisted vs. unassisted) * role (speaker vs. helper) interaction. On average, children in both countries judged the speaker to be more blameworthy than the helper in the unassisted condition ($p < .0001$), but judged both the helper and the speaker to be equally responsible in the assisted condition ($p = .304$). Children's explicit liking for the two agents also showed the same pattern. Moreover, children from both countries were more likely to trust the helper for new information in the unassisted condition compared to the assisted condition ($p < .001$). These findings suggest that Chinese and American children held both a helping speaker and a deferential speaker responsible for misinformation passed on to a third party.

1-F-122 Flexibility in children's selective social learning based on group membership

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This research examined 4- to 5-year-old children's selective social learning based on group membership when acquiring culturally neutral versus culturally specific information. In two experiments, White Canadian children preferred to ask their racial ($N = 48$; $p = .002$) and accent ($N = 42$; $p = .018$) ingroups for culturally neutral information (e.g., novel object functions), but did not show this ingroup preference when learning culturally specific information (e.g., a Chinese dance). Chinese Canadian children preferred to ask White (vs. Chinese) individuals for culturally neutral information ($N = 32$; $p = .032$), but favored Chinese-accented (vs. native-accented) individuals for information pertinent to the Chinese culture ($N = 23$, $p = .045$). These findings suggest that 4- to 5-year-old children are flexible in making selective learning decisions based on group membership, taking into account the privileged status of outgroup others as a source of information pertinent to their respective culture.

1-F-123 The role of gender in preschool teacher ratings of children's self-regulation.

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Research has shown that teachers consider boys to be more disruptive than girls in a classroom context (Jones & Myhill, 2004). Furthermore, boys receive more frequent discipline and suspensions than girls during preschool (Gilliam et al., 2016) and beyond (e.g., Skiba, Michael, Nardo, & Peterson, 2002). Children with lower levels of self-regulation often have higher levels of behavioral problems (e.g., Alderson, Rapport, & Kofler, 2007). Yet, little is known about the role of gender in preschool teachers' behavioral ratings of emotion regulation and executive function. Thus, this study examined gender differences in preschool teachers' ratings of self-regulation. Preschool teachers ($N = 375$) completed the Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997) and the Behavior Rating Inventory of Executive Function--Preschool (BRIEF-P; Gioia, Espy, & Isquith, 2003) on children in their classroom (ages 3-5). Teachers perceived girls and boys as similar on appropriate emotional expression, empathy, and emotional self-awareness, $F(301) = 2.75$, $p > .05$. However, teachers perceived boys to be more rigid, labile, and dysregulated than girls, $F(302) = 4.92$, $p < .05$. Teachers also rated boys lower on emotional control compared to girls, $F(301) = 6.11$, $p < .05$. More complex analyses are forthcoming. Final results may provide insight into the differential gender discipline in preschool and inform educational policy.

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1-F-124 Executive function relates to social problem solving and friendship quality in middle childhood

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In the current study, we examined whether cognition (and EF in particular) influenced friendship quality and social problem solving in middle childhood. Children (N=81; 7- to 10-year-olds) completed EF measures of cognitive flexibility, inhibition, and working memory (Miyake & Friedman, 2012) in addition to measures of verbal and nonverbal intelligence. Friendship quality was measured via children's self-reports on the quality of their best friendship (Parker & Asher, 1993) and social problem solving was measured via children's reports of their interpretations, goals, and strategies in response to a hypothetical transgression with a friend (Paquette MacEvoy & Asher, 2012). With regard to friendship transgressions, cognitive flexibility was related to more neutral interpretations and verbal ability was related to fewer devalued interpretations of transgressions. Inhibitory control and better verbal ability were related to fewer revenge goals. For friendship quality, better working memory performance was related to worse friendship quality and better verbal ability was related to less friendship conflict. Results suggest cognitive abilities may be an important factor to consider when examining more sophisticated friendships and social problem solving in middle childhood, and cognition may even relate counterintuitively to friendship quality (e.g., those with worse working memory may perceive more positive friendships due to issues with correctly evaluating friendships).

1-F-125 Are you talking to ME?! An exploratory study of toddlers' responsiveness to prompts from a video chat partner

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Social contingency facilitates children's learning from video and video chat. Prior research exclusively addresses infants' learning from video chat, and responsiveness to video chat partners has not been examined. Infants' responsiveness influences whether or not they receive contingency feedback from on-screen interactions, and thus influences opportunities to perceive the interaction as contingent. We report an exploratory study of infants' responsiveness to bids from a video chat partner across three types of prompts (labeling a novel object, imitating a novel object action, imitating an action without an object; within-subjects) and two conditions (contingent vs yoked; between-subjects). Individual differences were explained by age (more responsiveness with increasing age), gender (girls were more responsive than boys) and television viewing frequency (more responsiveness with daily viewing). Responsiveness to prompts that occurred earlier versus later in a single session did not change systematically, but there were higher levels of responsiveness to actions (e.g., waving to partner, imitating partner's action with an object) than to verbal prompts (e.g., repeating a word). Children were also more responsive to a socially contingent partner than to a yoked one, but only for verbal prompts and not for actions. Results suggest that individual differences provide rich information for future research on young children's responsiveness to and learning from screen media.

1-F-126 A neurophysiological connection between emotions children see and feel: Exploring links between LPP and N170 ERP components

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Behavioral research suggests links between children's own internal emotions and those observed in others' facial expressions. However, the connection between emotions that children feel and see is little explored or understood on a neurophysiological level. Examination of associations between these two emotion processes offers a potentially more sensitive and nuanced picture of whether and how these two processes are related. In two different tasks, participants had their brain activity (event-related potentials; ERP) recorded as they passively viewed emotionally arousing images (from the International Affective Picture System) and faces expressing different emotional valences (from the "Nim Stim" database). We examined relations between the "Late Positive Potential; LPP" (an ERP component associated with experiencing emotional arousal), and the "N170" (an ERP component associated with decoding others' facial expressions). Data collection is on-going. Preliminary findings from 14 children showed that children's more negative N170 mean amplitude to all emotion categories was associated with a reduced LPP mean amplitude to pleasant emotions ($r = .559$, $p = .038$), suggesting a neurophysiological link between feeling one's own emotions and decoding others' expressions of emotion. These findings shed light on the different facets of emotion development, and on the function of the LPP and the N170. They also have implications for understanding mechanisms underlying the development of mood disorders.

1-F-127 Listen to your mother: Children's understanding of power in hierarchical social roles

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Humans live in a web of interpersonal relationships where social power is unevenly distributed. Learning to navigate social hierarchies is an important element of children's social cognitive development. Using a selective trust paradigm, we presented informants with different levels of social power (e.g., mother vs. daughter) to participants. The informants gave conflicting instructions and we asked 45 4- to 6-year-olds to answer two questions: 1) Which instruction should be followed, and 2) Who can tell someone what to do? Children's responses differed by age for each question (Q1: $F(2,44)=6.96$, $p=.002$; Q2: $F(2,44)=6.64$, $p=.003$). Six-year-olds selected the dominant informant's instructions and judged that the dominant informant could tell others what to do at rates significantly greater than chance, $p<.001$, and significantly more often than 4- and 5-year-olds, $ps<.040$. Five-year-olds determined that dominant informants could tell others what to do at rates significantly greater than chance but did not show a preference for their instructions. Four-year-olds responded randomly, and their responses did not differ from 5-year-olds'. Children's recognition that individuals hold roles of varying power improved with age. However, they did not privilege the instructions presented by individuals holding those roles. In other words, children know that they should listen to their mothers, but do not always follow their instructions.

1-F-128 Scale errors are induced by associating functions to categories of objects in 3-year-old children

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It has been suggested that children's proneness to commit scale errors originate from their propensity to reason about artifacts as existing to fulfill a specific function. In this view, children overlook size information because they focus on the function with which the given tool category is associated. However, it has not been directly tested whether categorization indeed plays a part in the phenomenon.

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In this study, 3-year-old children ($n=51$) were presented with object sets consisting of a target and a potential tool to bring about a certain goal. First, a model demonstrated the object functions. After this, children were handed the object sets, however, the sets contained an important alteration. In the experimental condition, the original tool was replaced by one that differed in two characteristics from the original one: it was differently colored and was oversized. In the control condition, the oversized tool was the same color. Children were also provided with a novel, affordant tool. Participants committed scale errors both when the oversized tool was otherwise identical to the original one (41%) and when it was a different colour (48%). These percentages differed significantly from a baseline (24%) where the goal was merely pointed out to children but there was no function demonstration. The results show that scale errors can be attributed to children's tendency to generalize object functions from a single demonstration.

1-F-129 Valence or traits: developmental change in children's use of facial features to make inferences about others

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Children predict others' behavior from their facial features (i.e., thin-slice behavior) (Charlesworth et al., 2019). It is not clear what drives these face-based decisions. Are preschoolers associating traits (e.g., competence) with these faces? Or are they evaluating faces based on valence (e.g., positive or negative)? Here, 32 4- and 5-year-olds made inferences about pairs of positively-valenced faces with different traits: one competent-looking and one trustworthy-looking. Although 5-year-olds selected the trustworthy faces more often for questions about who would draw a better picture, $t(12) = -2.35$, $p = 0.037$, $d = -1.36$, and who would be a better sharer, $t(12) = -3.63$, $p = 0.003$, $d = -2.09$, 4-year-olds showed no preferences. These effects were even apparent on the first trial (Table 1). Only 5-year-olds distinguished between two positively-valenced faces with different traits, evaluating others based on domain-specific traits; younger children may rely on valence instead.

1-F-130 The role of religious status on children's judgments of who is real and what is possible

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Children have a good grasp of the distinction between fantasy and reality from an early age (Sharon & Woolley, 2004) and can use contextual cues to make this distinction (Corriveau et al., 2009). However, exposure to religion may render children more credulous of the impossible (Corriveau et al., 2015). To extend previous findings, we presented 141 younger (5-to 7-year-olds) and older (8-to 11-year-olds) children attending religious or secular schools in the United States (71 females, $M = 8.02$ years; $SD = 2.02$ years) with religious, magical, realistic, and unusual versions of 12 novel stories. As seen in Figure 1, children's "real" judgments shifted dramatically by story type. A mixed binomial logistic model revealed that the school type and story type interaction was significant when comparing realistic stories to religious, $\beta = 0.97$, $SE = 0.35$, $z = 2.80$, $p < .005$, and magical stories, $\beta = 1.17$, $SE = 0.52$, $z = 2.27$, $p < .05$, but not when comparing them to unusual stories. These findings support and extend previous research by demonstrating the role of religious exposure on children's possibility judgments. Although children enrolled in religious and secular schools made similar judgments about realistic and unusual stories, children in religious schools were more likely than children in secular schools to judge the religious and fantastical stories as real.

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1-F-131 The effects of testimony on children's and adults' evidence processing during category learning

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When learning about categories, at our disposal is our firsthand experience and information provided from others via language--i.e., testimony. The current study explores how these two sources of information interact during category learning by examining (1) whether generic testimony impacts how children and adults process firsthand experience about a novel category, and (2) whether children and adults integrate or preferentially rely on one source of information. Participants (44 adults, 14 children; data collection ongoing) were given experience with samples of novel animal categories either before or after receiving generic testimony about a property (e.g., Tomas have stripes). Samples differed in whether the target property was high or low in prevalence and thus whether experience was primarily consistent or inconsistent with testimony. Eye-tracking was used to assess how participants processed the evidence and counterevidence in the samples. Initial analyses suggest that adults who heard generic testimony (e.g., Tomas have stripes) spent relatively less time looking at the evidence (e.g., the animals with stripes) and relatively more time looking at the counterevidence (e.g., the animals with spots) than adults who had not received prior testimony--suggesting that hearing generic testimony biases adults to attend to evidence that is inconsistent with that testimony. Further analyses will explore whether 5-7-year-olds share this attentional bias. Additional analyses will also examine whether adults and children subsequently rely on firsthand experience, testimony, or a combination of the two when teaching others what they learned.

1-F-132 Intuitive archeology in childhood: Children detect social transmission in the design of artifacts via inverse planning

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Do children use human-made objects (artifacts) to learn about the people and actions that created them? We test the richness of children's reasoning, focusing on the task of judging whether social transmission has occurred (whether one person copied another). Do children use a simple perceptual heuristic (more similar = more likely copied), or rich, explanation-based reasoning? We develop a formal model of this as inverse planning, which predicts that similarity should be weaker evidence of copying when functional constraints provide an alternative explanation for similarity (only one design would work). We test this prediction (N=155; 4-5 years old): A child and a puppet each built a tool to reach a button inside a box, picking 1 of 10 different-shaped rods to connect to a handle. We varied the functional constraints: Half of children solved a box with a round hole, where all 10 rods would fit; others saw a star-shaped hole, where only one (star-shaped) rod would fit. The puppet always built an identical tool to the child; children judged whether the puppet had copied them. If children use only perceptual similarity, they should infer copying equally often in both conditions. In contrast, children inferred copying less often when functional constraints provided an alternative explanation ($\chi^2(1, N=155)=8.94, p<0.01$). When thinking about artifacts, young children go beyond perceptual features and use a process like inverse planning to reason about how artifacts were generated.

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1-F-133 Canadian children aged five to eight have an essentialist view of national identity

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Introduction. Children use an essentialist strategy to understand social categories like gender and race, categorizing people based on an undefined essence, rather than surface level features. Hussak & Cimpian (2019) found that American children, aged five to eight, use an essentialist strategy to understand national identity. They see national identity as stable, heritable and as having a biological basis. Whether all children understand national identity in essentialist terms, or if essentialism is specific to countries like the United States with strong national identities is unknown. **Methods.** The current study tests if Canadian children also understand national identity in essentialist terms. Seventy-nine children were interviewed testing seven different factors: stability, heritability, inductive potential, conventions, biological bases, meaning, and acquisition. **Results.** Essentialism scores on each factor were significantly different from 0. Canadian children demonstrated essentialist thinking with respect to stability ($t=16.4$, $p<0.001$), heritability ($t=10.55$, $p<0.001$), inductive potential ($t=21.57$, $p<0.001$), conventions ($t=8.61$, $p<0.001$), biological bases ($t=21.61$, $p<0.001$), meaning ($t=8.94$, $p<0.001$) and acquisition ($t=4.45$, $p<0.001$). There was a significant negative relationship between age and two essentialism factors: heritability ($b=-0.14$, $p<0.01$) and conventions ($b=-0.1$, $p<0.05$). This suggests that children are becoming less essentialist with age. Canadian and American children both use essentialist strategies to understand national identity. The negative relationship between age and some essentialism scores is consistent with other social categories in the literature.

1-F-134 Girls, but not boys showed an increased sense of commitment to collaboration after their partner invested high vs. low cost

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Commitments facilitate cooperation. Previous studies have focused on children's understanding of commitments made through explicit verbal communication. However, we sometimes also act committed even in situations in which no explicit agreements are made. Thus it would be valuable to elucidate the mechanisms that give rise to such a 'sense of commitment'. Does one partner's investment of costs in a collaborative action influence a second partner's sense of commitment to their collaboration? To test this, we manipulated the cost that children's partners (a same-sex peer) paid, and measured 7- to 8-year-old children's sense of commitment, operationalized as the effort they invested in a collaborative task. In this task, children moved a snake through a maze by repeatedly pressing a button. To unlock each game round, children's partners paid either a colorful sticker (high cost condition) or a simple sticker (low cost condition). In a within-subject design, we measured the frequency with which children pressed the button: a higher frequency of keypresses signals an increased sense of commitment to their task. The results ($N=61$) revealed unexpected gender differences: while girls indeed invested significantly more effort in collaboration when their partner paid a high vs. low cost (Wilcoxon test, $p=.026$, $ES=0.46$), boys did not alter their effort ($p=.702$). Potential explanations for these findings such as enhanced perspective taking in girls are discussed.

1-F-135 Exploring the mature theory of mind system: The unique implications of theory of mind skills and dispositional tendencies for everyday theory of mind use

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Theory of mind (ToM)--the ability to reason about others' mental states--is a key cognitive capacity underpinning our ability to engage in social interactions. Existing research has largely focused on explaining ToM origins and development in early childhood. However, much can be learned from examinations of ToM beyond childhood (Apperly, 2011). Specifically, an adult sample affords opportunities to examine components of the fully developed ToM system and their unique implications for ToM utilization in everyday social contexts. To this end, the present study explored three potentially distinct constructs of the mature ToM system. The first involves the capacity to infer others' mental states from facial expressions (Mind in the Eyes; Baron-Cohen et al., 1997) and based on contextualized processing of complex social interactions (Movie for the Assessment of Social Cognition, MASC; Dziobek et al., 2006). The second construct includes dispositional components of ToM, namely tendencies to deliberately consider others' mental states ("When I'm upset at someone, I usually try to put myself in her shoes for a while;" Interpersonal Reactivity Index, IRI, Perspective Taking subscale; Davis, 1980), and to experience emotional responses to the plight of others ("I would describe myself as a pretty soft-hearted person;" IRI Empathic Concern subscale). Lastly, the third construct represents effective use of ToM abilities in everyday social contexts, assessed via friend-report ("My friend knows how her actions will make others feel;" Questionnaire of Cognitive and Affective Empathy, Reniers, et al., 2011; Tromso Social Intelligence Scale, Silvera et al., 2001). 115 dyads of close friends participated (n = 230). Participants completed measures of their own ToM skills (Mind in the Eyes, MASC) and dispositional tendencies (IRI Perspective Taking, Empathic Concern) and rated the ToM use of their friend. Analyses considered two key questions: What is the relation between the capacity to accurately infer others' mental states and the dispositional tendency to think about and experience affective responses to others' mental states? How do these components of the ToM system relate to effective reasoning about others' mental states in everyday social contexts? Results showed that ToM skills were positively related to dispositional aspects of ToM ($r_s = .15-.28$, $p_s < .028$). However, ToM skills and disposition emerged as two distinct factors in factorial analyses. Regression analyses revealed that skill inferring mental states from complex social interactions and the dispositional tendency to experience affective responses to others were independent predictors of ToM use above any effects of gender, social desirability, extraversion, and verbal fluency ($\beta_s = 0.14-0.15$, $p_s < .048$; no interaction). Overall, findings suggest that ToM skills and dispositional tendencies are related but distinct constructs in the mature ToM system. Importantly, components of both of these constructs--the ability to make mental state inferences from complex social interactions and the dispositional tendency to experience affective responses to the plight of others--predict effective utilization of ToM in everyday social interactions as reported by friends. Additional analyses will account for potential bias from participants' own ToM skills in reporting on their friend's ToM use. The implications of these findings for defining and measuring ToM across development will be considered.

1-F-136 Parents' beliefs about the benefits of pretend play in early childhood

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Pretend play is a childhood activity many parents believe important to development. Using a survey, we examined 68 parents' beliefs about the benefits of realistic and fantastical pretend play and whether

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parents should engage in pretend play with children. On 5-point scales, parents rated both realistic ($M = 4.10$, $SD = 0.53$) and fantastical ($M = 3.94$, $SD = 0.65$) pretend play as important to children's development, with realistic pretend play marginally more important than fantastical pretend play, $t(66) = 1.90$, $p = .062$, Cohen's $d = 0.23$. They believed realistic pretend play allows children to practice skills, roles, and interactions; develop independence and responsibility; and build confidence, and fantastical pretend play allows children to develop creativity, imagination, problem-solving, and reasoning, and process emotions and experiences. They believed pretending with their children was as important as other activities they do together ($M = 3.38$ of 5, $SD = 0.70$). Some believed joint pretend play is important because it validates play; provides a way to connect with their child; allows the child control; and allows parents to direct, model, and teach. Others believed it less important because children must learn to be independent and adults stifle children's creativity and engagement. Differences by demographics will be discussed. This study furthers understanding of parents' beliefs about pretend play and is among the first to distinguish realistic from fantastical pretend play.

1-F-137 Just because Mickey Mouse said it doesn't make it impossible: How informant reality status and familiarity influence children's belief in extraordinary events

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As children get older, they become better able to discriminate between impossible and improbable statements and realize that improbable events can occur in reality while impossible ones cannot (e.g. Shtulman & Carey, 2007). However, when children hear about extraordinary events from fictional entities (e.g., popular characters from children's media), younger children may have more difficulty determining whether the events could occur in reality (e.g., Li, Boguszewski, & Lillard, 2015). The current study examines how an informant's reality status (human or fictional character) and familiarity influence children's belief in statements about improbable and impossible events. Children ages 4, 6, and 8 ($N=56$) heard 4 impossible and 4 improbable statements from an unfamiliar person, a familiar character (Mickey Mouse), or an unfamiliar character (cartoon mouse) and judged whether each statement could happen in real life. As in previous studies, older children were more likely to believe improbable events could occur than younger children. Additionally, for both types of statements, children's judgements about the possibility of the events were similar regardless of which informant said them. These results suggest that when children hear extraordinary statements provided by fictional characters, including unfamiliar ones, they treat the information in the same way as if they heard it from a real person. Implications for children's learning from media will be discussed.

1-F-138 Reward enhances children's attention to underlying statistical information of emotional expressions

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In the present study, we examined children's ability to adjust to the emotional expressivity of three different individuals by tracking statistical information. We also tested whether children were more successful at tracking this information when they were rewarded. 6 to 10-year-olds were divided into two groups: one in which they were told their performance determined the prize they would get (reward), and one in which they were not given this information (no reward). For the main task, children viewed morphed angry facial expressions of varying intensities and classified these expressions as upset

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or calm. Children saw different statistical distributions of faces for three actors. We wanted to see if children identified anger differently for each actor based on the distributions encountered. Using a logistic generalized linear mixed effect model, we found that all children were able to track individual differences in expressivity among the three actors, $\chi^2(2)=26.41$, $p<.001$; however, the reward group did so more accurately, $\chi^2(2)=6.72$, $p=.03$. Differences between groups may be driven by how long participants looked at each facial expression, as participants in the reward condition had longer reaction times, $b=242.81$, $t=2.89$, $p<.01$. Taken together, these data suggest that reward may facilitate children's attention to underlying statistical information. This attention then allows children to more accurately track different categorical distributions.

1-F-139 Do children always trust confident individuals? Not when it comes to moral deliberations

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Children and adults often treat confident individuals as more credible sources when learning new information. However, confidence may not be a marker of credibility outside of factual claims, such as in moral questions. We examined children's judgments of informants who differed in their level of confidence in two domains of knowledge (factual and moral). Children 3-8 years ($N=96$) listened to a confident and a hesitant speaker make claims about either factual information or moral decisions. After each claim, children rated the speaker's level of confidence, likeability, smartness, and agreement with the speaker. A 2 (confident, hesitant) x 2 (factual, moral) ANOVA indicated a main effect of level of confidence ($p<.001$) and significant interactions between domain and model confidence in children's ratings of liking, smartness, and agreement ($ps\leq.02$) (Figure 1). That is, children favored the confident model in the factual domain, but became skeptical of the confident model in the moral domain, favoring the hesitant model instead. As these findings demonstrate, children not only attend to the confidence of informants, but also simultaneously weigh the type of information (factual or moral). This remarkable capacity at such a young age (3 to 4 years) allows children to discern who is a trustworthy source of information across contexts, which has important implications for children's learning and the transmission of knowledge.

1-F-140 Associations between aggression type, gender, and intentionality on children's trait attributions toward transgressors

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Social decisions about transgressors vary by gender, as children associate physical aggression with boys and relational aggression with girls (Giles & Heyman, 2005). Although children's trait attributions toward transgressors are often negative (Boseovski, Lapan, & Bosacki, 2013), children produce harsher explanations for transgressors with ambiguous intentions, especially if the actor is a boy (Giles & Heyman, 2004). It is unclear how aggression type, transgressor gender, and a transgressor's intentions interact to shape children's social judgments, although all three factors are present together in the real world. We examined whether children's trait attributions (i.e., nice, mean, not nice or mean) toward transgressors varied by aggression type, transgressor gender, and the clarity of a transgressor's intentions. We presented 139 5- to 10-year-olds with two relational aggression stories and two physical aggression stories. Transgressor gender was split evenly for each story type. Across stories,

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intentionality was ambiguous or unambiguous. Physical transgressors were rated as nicer than relational transgressors, especially if they had ambiguous intentions, $F(1, 137)=36.15$, $p<.001$, $\eta^2=.21$. There was no effect of transgressor gender, $ps>.05$. Children likely interpreted ambiguous acts as accidental (Yuill & Perner, 1988), which elicited positive trait attributions. This was especially true for physical transgressors, perhaps because relational transgressors often act covertly (Crick, 1997). Aggression type and intent overpower gender in aggression contexts, implying that who committed an aggressive act is not as relevant as what the act was and why it was committed.

G – Cognition in diverse environments

1-G-141 "I wanna play in here!": An observational investigation of childhood play in indoor and outdoor exhibits

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Childhood play contributes greatly to cognitive and social skills (Rivkin, 2000). However, there are key differences in the structure, quality, and educational value of indoor versus outdoor play (Bixler, Floyd, & Hammitt, 2002). Outdoor play positively impacts children's physical development and appreciation for nature, while indoor play provides structured activities and technological experiences (Ceglowski, 1997). One question that remains is how play-based museum exhibits scaffold these benefits and parent-child interest in educational play. Therefore, we examined parent-child play at one indoor and one outdoor play-based exhibit at a science center. Thirty-three 3- to 9-year-olds ($M = 5.46$ years, $SD = 21.89$ months, 19 females) and their parents were recruited from either an outdoor exhibit featuring live animals and agricultural replicas (e.g., farmhouse) or an indoor exhibit with nautical replicas (e.g., submarine) and sensor-based activities (e.g., hand-activated projections). Dyads spent as much time as desired at the exhibit ($M = 20.25$ minutes), while researchers observed. One researcher recorded the frequency of dyadic engagement with each exhibit area and the second recorded play behaviors. Three trained assistants familiar with both exhibits reliably classified each exhibit area according to Design, Play Type, Play Structure, and Skills Cultivated (see Table 1). ANOVAs with Exhibit (Indoor, Outdoor) and Area Classification as between-subjects factors were analyzed separately for each dimension to determine the exhibit characteristics associated with dyadic engagement. Results are presented in Table 2. A significant main effect of Exhibit revealed that dyads interacted with more indoor than outdoor exhibit areas. Significant main effects of Design and Play Type indicated that across Exhibits, technology-based areas were visited significantly more frequently than artificial replicas, live animals, or learning stations and that interactive or observational play areas were significantly more engaging than instructional or imaginative areas. A significant Exhibit X Play Structure interaction indicated that parent directed play ($M = 9.00$, $SD = .76$), over parent guided ($M = 1.00$, $SD = .94$) or child free play ($M = 2.41$, $SD = .57$), was associated with more dyadic engagement in the outdoor but not indoor exhibit, $F(2,29) = 30.69$, $.64$, $p < .001$, $p > .40$, $\eta^2 = .68$, $.03$, respectively. In both indoor and outdoor exhibits, $F(4, 27) = 2.71$, 11.57 , $ps < .05$, $\eta^2 = .26$, $.63$, respectively, areas that cultivated sensory skills, ($Ms = 11.86$, 6.00 , $SDs = 1.48$, 1.81) were more popular than those involving imagination ($Ms = 6.93$, 2.38 , $SDs = 1.01$, $.64$) or motor skills ($Ms = 7.88$, 2.50 , $SDs = 1.38$, 1.81). These findings suggest that indoor and outdoor play exhibits share similar designs but promote different play structures and skills. Consistent with previous work, indoor, technology-based play was more frequent than outdoor, active play. Given increased interest in distinct benefits of outdoor play-based learning (Clements, 2004), it is important to understand how to motivate

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outdoor play. Indeed, research indicates that technology offers only limited opportunities for creative thinking and social engagement (Levin & Rosenquest, 2001). The present research suggests that outdoor exhibits may encourage more social play than indoor exhibits and therefore provide valuable opportunities for joint parent-child engagement in play-based-learning

1-G-143 Playscapes as informal science learning environments: Age differences in preschoolers' conceptual change about plant life

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Preschoolers' (N = 42) concepts of plant life were investigated before and after six one-hour field trips to playscapes (outdoor, nature-based play environments). Preschoolers were presented with a small living plant and asked: 1) What do we need to take care of it? and 2) How do you think the plant will change if we take care of it? Then, they were presented with a picked plant and asked: 3) What do you think will happen to it now that I picked it from the ground? Analysis on scored responses revealed a significant Age Group X Probe X Assessment, $F(2, 39) = 3.97, p < .05$. For probe 1, there were no initial differences. By the post-assessment, 4-year-olds named more needs than 3-year-olds, who showed no change. For probe 2, there were no significant differences. For probe 3, 3-year-olds' demonstrated substantial growth, catching up with the 4-year-olds by the post-assessment.

1-G-144 Mediator role of learning approach and attention in the link between SES and academic achievement

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The associations between children's academic achievement, family socioeconomic status (SES) and general cognitive skills (e.g., executive function and attention; NICHD, 2003;) are evidenced. Children from low SES family showed deficits in executive function, attention and math skills than their peers from mid-to-high SES families upon the kindergarten entry and early elementary grades (Blums et al., 2017; Duncan et al., 2007; Lee, Park, & Ginsburg, 2013; NICHD, 2003). In addition to children's general cognition skills, children's learning approaches were also considered as an important predictor to academic achievement but was usually neglected. Learning approach was proposed by the National Education Goals Panel (NEGP, 1999), describing the quality of children's learning from several aspects, such as interests, initiation, concentration, persistence, etc. (Wang et al., 2010; Li et al. 2008). A considerable amount of studies have shown the bivariate relations among SES, attention, learning approaches and children's academic achievement, usually with math and reading separated (Blums, et al., 2017; Li et al., 2016). Little is known whether the path between SES and academic achievement (latent construct, indicated by both math and vocabulary) is mediated by learning approach and attention. The current study aimed at exploring the mechanism of how SES, specifically indicated by parents' education level, impacts on kindergarten children's academic achievement. We hypothesized that SES has a direct impact on children's academic achievement, as well as an indirect impact via learning approaches and children's attention process. Kindergarten children (N=149, Mean age=67.44 months) were recruited from classrooms in Shanghai, China. Children's family SES information, attention, learning approach, math ability, and vocabulary ability were obtained through parent's questionnaire, Child Attention Network, teacher-rated learning approach checklist, TEMA-3, and PPVT, respectively. The path model was tested using SEM techniques and Mplus 8 software (Muthen

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&Muthen, 2011) with a bootstrap approach (Shrout & Bolger, 2002). The "full information maximum likelihood"(FIML) estimation method was used for this non-recursive path model as a default. Results: Estimation of the model showed a just identified model with a perfect global fit, CFI = 1.000, TLI=1.053, RMSEA = .000, SRMR= .006. This path model explained approximately 41% variance in academic achievement, which is indicated by both math and vocabulary ability scores, 15% variance in learning approach, and only 5.5% variance in attention process. The tested model with standardized estimates is reported in Fig 1. SES has a direct impact on children's academic achievement, 95%CI [.234, .534], and an indirect effect on children's academic achievement via learning approach, 95%CI [.110, .313], and attention, 95%CI [.002, .116], although the effect via attention is small. The path model in the current study demonstrated the SES has both direct and indirect impacts on children's academic achievement. Learning approach and attention process played the role of mediators in this path model as hypothesized. Consistent with previous research findings, children with better-educated parents, showed higher academic achievement (Blums et al., 2017; NICHD, 2003); and, might not only because of the financial support and knowledge back-up but also because of the cultivated learning approaches, which sustain longer.

1-G-145 Gender nonconformity, peer relations, and anxiety and depression in transgender and cisgender children

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Higher degrees of gender nonconformity are often associated with more rejection from peers and worse psychosocial outcomes (Egan & Perry 2001; Landolt et al., 2004). Transgender children are an interesting group with which to examine similar associations because they allow us to understand whether these relations are driven by gender nonconformity (not conforming to cultural expectations based on one's gender identity) or sex nonconformity (not conforming to cultural expectations based on one's assigned sex at birth). We tested these questions in a sample of 525 children (272 transgender, 253 cisgender, Mage = 8.99). We found that children who were more gender nonconforming (i.e., not conforming to cultural expectations for their current lived gender) tended to have worse peer relationships and higher levels of anxiety and depression symptoms. Further, we found that peer relationships significantly mediated the relation between gender nonconformity and levels of anxiety and depression, suggesting that peer relationships may protect against the association between gender nonconformity and anxiety and depression. We also found that participant group (transgender vs. cisgender) did not moderate this effect. Thus even for transgender children, the greater the degree to which they strayed from their current gender role, the worse their peer relationships and the higher their levels of anxiety and depression.

1-G-146 Examining Egyptian adults' and children's knowledge of the origins of foods versus non-foods

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While there is a substantial body of research on children's knowledge for the origins of artifacts and natural kinds, this has yet to be fully explored in the food domain, which can be both natural and

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human-made. Furthermore, little research has examined children's concepts of food in non-Western samples. This research included an Egyptian sample as they have different patterns of experiences with nature and access to food. This research investigates Egyptian children's and adults' knowledge of the origins of familiar and unfamiliar artifacts, non-food natural kinds, and natural and processed foods. Fifty-six preschoolers and adults viewed pictures of those items and were asked if it was grown in a garden or made in factory. A 2 (age) x 2 (familiarity) x 4 (item) ANOVA revealed an Age x Familiarity x Item interaction, $F(3,162) = 8.32$, $p < .001$. Follow up tests revealed adults provided more correct responses for all items, $ps < .001$. Adults provided similar responses to all items with the exception of unfamiliar processed foods. However, a different pattern appeared for preschoolers, with more correct responses for non-food items versus both food types. Familiarity only influenced preschooler responses with more correct responses for familiar versus unfamiliar items. These results are similar to previous research on American children's knowledge of food origins. Additionally, Egyptian preschoolers may utilize different reasoning strategies for non-foods compared to foods.

1-G-147 Hey, look what I did!: A qualitative analysis of young children's play with a tablet-based STEM game

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While children can learn cognitive and social skills through different types of play, less is known about how digital play fits into the play landscape. Many schools have adopted a 1:1 iPad ratio, however, it is unclear how children behave during tablet sessions in which each child has their own tablet. There is little work examining if these tablet-based activities are solitary experiences or if they provide opportunities for a shared experience among young children. To address this, we coded videos of young children ($N=27$, $M= 5.15$ years) who played two different STEM games during a coding summer camp: Daisy the Dinosaur and Kodable. During each tablet session, each child had their own tablet, but played the same game as their peers while sitting at the same table. We used a grounded theory approach to code the different types of behaviors children engaged in (i.e. celebrations, sharing) and questions children asked (i.e. for help, how to play). Currently, video tapes are being coded for reliability and the poster will report on the qualitative analysis. Codes derived through this project may have implications for how these different play behaviors impact learning from a STEM tablet game.

1-G-148 Influence of culture and priming on analogical reasoning performance across development

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Relational reasoning, the ability to reason on the basis of structural similarities between representations, undergoes developmental change. Younger children spontaneously attend to surface (featural) similarities while older children shift to attending to structural, relational similarities (Richland, Morrison, Holyoak, 2006). This study explores the roles of national culture, problem-type sequence, and priming on the developmental trajectory. In Experiment 1, Chinese ($N = 172$) and US ($N = 117$) children ages 4-11 completed an ambiguous structure mapping task with relational and featural similarities. No cultural differences were found. Overall, participants were prone to select featural responses in the first four trials ($M = 77\%$). After brief exposure to trials without featural similarities, age predicted a shift to relational response selection upon re-introduction of featural similarities ($\beta = 0.04$, $p < 0.001$). In

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Experiment 2, 141 additional US children completed a relation generation priming task prior to the mapping task. No differences in initial trial responses, as compared to the unprimed US children, were found. However, priming predicted increased relational similarity selection after removal and reintroduction of featural similarities ($\beta = 0.13$, $p < 0.001$). This study suggests that context, but not culture, impacts malleability of this developmental trajectory more than previously assumed by strict domain knowledge acquisition or age-based maturation models.

1-G-149 Can we make analogous executive functions tasks across computerized and naturalistic testing environments?

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Rationale: Studies of working memory (WM) show that children flexibly transfer rules learned in one context, to a novel similar context. Thus, WM task performance may vary by experiences in children's daily lives that transfer to the laboratory setting. Here we asked whether (1) WM performance is comparable across computerized and play-based testing contexts, and (2) whether digital device use has an impact on WM performance in computerized settings. Methods: Sixty 4-6-year-olds participated in two-sessions. During each session a 3 condition WM task (1st Order-Low WM Load, 1st Order-High WM Load, 2nd Order-High WM Load) were administered either digitally or naturalistically. A digital device use questionnaire was collected. Results and Conclusions: Our results suggest that the tasks were comparable in difficulty across settings ($F(2,36) = 40.477$, $p = .000$). Digital device use in the older children was associated with better WM accuracy during the Computerized session only ($F(1,47) = 5.472$, $p < .05$). Developing WM performance may be influenced by rules for action that children can transfer to the laboratory.

1-G-150 Reliability estimates of scale measuring young children's self-perceptions of cognitive control

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Cognitive control skills in early childhood are important for many life outcomes across diverse domains (e.g., Moffitt et al., 2011; Schmidt, Pratt, & McClelland, 2014). Similarly, one's self-perceptions of various skills have been shown to predict meaningful variance in important outcomes including academic performance (e.g., Bong & Skaalvik, 2013; Dweck & Leggett, 1988; Lyons & Ghetti, 2013). A psychometrically sound method for measuring young children's self-perceptions of cognitive control skills is needed. In a recent study, a newly developed interview scale capturing these self-perceptions showed strong internal consistency and external validity (Ross & Baldwin, under review). The current research replicates and extends these findings with further reliability estimates. 97 4-6-year-olds completed the new interview scale. 40 of these children were re-tested within two weeks of their first interview. As in previous work, inter-rater reliability was excellent, $ICC = .99$, and internal consistency estimates for the entire scale were quite strong, Cronbach's $\alpha = .80$. The overall retest reliability estimate was also strong, $r(38) = .82$. Scale development is an iterative process and these findings further suggest the new scale holds potential to uncover how children's self-perceptions influence their learning success.

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1-G-151

Expression of metacognition in online STEM courses: Functions and effects

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Metacognition is a valuable tool for learning, especially in online learning contexts, due to its close relation to self-regulation. Research on metacognition has used traditional methods such as surveys; however, the research lacks large-scale methods dealing with spontaneously produced language. This project developed an algorithm for automatic detection of written metacognitive language. Text was analyzed from an online forum, in an introductory university-level science course. The algorithm exhibited a reliable, fast method for automatically annotating text corpora too large for manual annotation. Subsequently, logistic regression was used to model students' academic performance as a function of their metacognitive language. Later, patterns amongst demographic groups were analyzed, in hopes of understanding the academic behaviors of underrepresented students in online STEM courses.

Session 2

A – Perception, action, attention, and cognitive control

2-A-1

What leads to coordinated attention in parent-toddler interactions? Children's hearing status matters

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Coordinated attention between children and their parents plays an important role in their social, language, and cognitive development. We used head-mounted eye-trackers to examine whether children with and without hearing loss use different pathways to achieve coordinated attention with their parents during play interactions. Three groups of toddlers (aged 12-37 months) and their parents participated in the study. These children were toddlers with hearing loss, hearing controls matched on chronological age, and hearing controls matched on hearing age. We investigated how often parents and children achieved coordinated attention to the objects by following each other's gaze versus following their manual actions on the objects. Children's hearing status did not affect how likely parents and children jointly attended to the same object during play. However, when following parents' attention, children with hearing loss relied more on the direction of their parents' gaze, while children with normal hearing relied more on their parents' hand actions. Our study reveals that children's hearing status affected the pathways they used to coordinate attention with their parents. The diversity of pathways leading to coordinated attention suggests the flexibility and robustness of developing systems in using multiple pathways to achieve the same functional end.

2-A-2

Developmental differences in attention filtering and visual working memory capacity

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Given the capacity limit of visual working memory (VWM), it can be difficult for us to filter out task-irrelevant information from entering into VWM. We investigated the developmental trajectory of VWM and its association with attention filtering ability. Adults, adolescents (aged 12-14), and children (aged 8-9) performed an object change detection task with two cued targets presented either alone or with distractors. After a brief retention interval, one object was presented, and participants judged whether

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it matched either of the previously presented targets. A surprise object recognition test was then administered to measure memory for both targets and distractors. We found that adults and adolescents have comparable VWM capacity and attention filtering ability, in that they show similar memory for targets presented with or without distractors. However, children have lower VWM capacity than adults and adolescents and show greater memory for targets presented alone compared to targets presented with distractors.

2-A-3 Neural motor activity during perception of familiar and unfamiliar means-end actions in 9-month-olds

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The current study examined the presence and differences in neural motor activity during perception of means-end actions of grasps(familiar) and tool-use actions(unfamiliar) presented via video (Figure 1). Results show mu ERD indexing motor activity during perception of both familiar and unfamiliar means-end actions. Yet, surprisingly, we did not find any evidence for conditional differences between familiar and unfamiliar action(Figure 1). We are further working on looking at motor activity on each trial to examine continuous mu power over time. This analysis will allow us to investigate differences in the pattern of motor activity between conditions over time; e.g. more motor activity for unfamiliar action in later coming trials. These results provide evidence for neural system that supports the perception of actions with and beyond infants' motor repertoire in the first year of life.

2-A-4 The relationship between physiological reactivity and executive function in young children

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We sought to understand how baseline respiratory sinus arrhythmia (bRSA), a measure of physiological reactivity, is associated with components of 36-month-old children's executive function (EF). bRSA was computed from heart rate measured while children watched a short affective-neutral video, with higher bRSA indexing higher physiological reactivity. Children (N=51) completed a battery of EF tasks, including response inhibition (e.g., Stroop), delay of gratification (e.g., toy delay), working memory (e.g., Spin the Pots), and task-switching (e.g., Dimensional Card Sort). High-bRSA children performed better on delay of gratification and some response inhibition tasks compared to low-bRSA children (all $t(50) > 2.14$, $ps < 0.05$), but there were no differences for working memory, task-switching, or behavioral reactivity (surgency and effortful control), as assessed by parental reports. bRSA was not correlated with longitudinal assessments of bRSA in the same group of children during infancy and toddlerhood. Results suggest that concurrent physiological reactivity may be more strongly related to "hot" executive function, such as situations requiring impulse control or that are more affective than cognitive (e.g. Zelazo & Carlson, 2012).

2-A-5 Effects of toy type and caregiver availability on infants' free play activity

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Where infants go and what they see and do determines their opportunities for learning. To support and facilitate spontaneous locomotor activity, it is important to understand the environmental and social factors that prompt infants who can move to get up and go. Here, we tested whether toy type and caregiver availability during free play affect infants' spontaneous locomotion. Using a within-subjects design, we recorded 15- to 22-month-old infants ($N=20$, planned $N=40$) in 4 crossed conditions (8 min/condition): playing with toys designed to elicit locomotion (e.g., stroller) or toys designed to be used during stationary play (e.g., blocks), both with and without their caregivers. Infants spent more time in motion, took more steps, initiated more bouts of locomotion, and moved more with toys in the locomotor-toy conditions compared to stationary-toy conditions, regardless of caregiver availability, $F_s \geq 21.3$, $ps \leq .001$, Figure 1A-D. Moreover, in the stationary-toy conditions, caregiver availability further depressed movement compared to when infants played independently, $F_s \geq 5.7$, $ps \leq .03$. Caregiver availability did not affect the percent of bouts spent moving with toys, $F = .41$, $p = .53$, Figure 1D. These patterns were consistent across infants' age and walking experience (Figure 1E-H, infants ordered by months of walking). In sum, locomotor toys consistently incite infant movement and exploration, but when stationary toys are available, caregivers elicit more stationary play.

2-A-6 Using the TrackIt Task to study the development of selective sustained attention in children ages 2-7

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TrackIt was developed as a measure of selective sustained attention that is (1) developmentally-sensitive and (2) able to partially separate exogenous and endogenous factors affecting attention regulation. However, these predictions have only been investigated with a limited set of parameters within a limited age range (3-5 years). This preregistered study (anonymized preregistration <https://aspredicted.org/blind.php?x=q7q4im>) reports the first systematic effort to examine performance on TrackIt in an expanded parameter space and age range. We randomly assigned 2.5-7 year-old children ($N=240$) to difficulty levels (i.e., parameter combinations) expected to be appropriate to their age (i.e., not inducing floor or ceiling effects). We included a within-subject manipulation of condition (High versus Low Exogenous support, indicated by salience of the target relative to distractors). Previous studies using TrackIt reported effects of age and condition in a small parameter space and age band; we replicated and extended these findings. We found in most levels medium-to-large effects of age (Cohen's $d_s = 0.23-2.21$) and a small effect of condition (Cohen's $d_s = 0.13-0.42$) on performance. These results contribute to the body of evidence that selective sustained attention (1) improves with age and (2) is bolstered by exogenous support. However, contrary to our preregistered hypothesis, we did not find that younger children benefited more from exogenous support relative to older children.

2-A-7 Explore versus store: Children strategically trade off reliance on motor exploration versus working memory during a complex task

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As cognitive and motor demands of a task vary, adults strategically shift between exploration of the environment and reliance on working memory (WM) (Kibbe & Kowler, 2011). We asked whether children ($n=42$ 8-10-year-olds) also make efficient decisions about when to explore versus store.

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Children clicked through sets of objects, viewable one-at-a-time, to find three that belonged to a category defined over the objects' features (Figure 1a). We manipulated 1) the cognitive demands of the task by increasing the complexity of the category (including more features and dimensions of features in the category rule), and 2) the motor demands of the task by varying the lag to view the object after a click (0s or 1s). Children's click behavior suggested that they strategically traded off reliance on exploration versus WM depending on task demands (Figure 1b). As cognitive demands increased, children visited and revisited items more often, freeing WM for the categorization task ($p < 0.01$). As motor demands increased, children explored less ($p < .02$), relying more on WM. These data suggest that children, like adults, make strategic decisions about when to explore versus when to store, coordinating both the cognitive and motor requirements of a complex task.

2-A-8 Linking attention and executive function from toddlerhood to early childhood: Integrating ocular-motor, behavioral, and hemodynamic responses

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Basic attentional processing (i.e., orienting, alerting, executive attention) and efficiency in infancy has been linked with long-term cognitive, social-emotional, and executive processing outcomes in childhood 1 2 3 . One notable transition in attentional functioning during early childhood occurs with the emergence of executive function. However, little is known about how basic attention processes relate to attention in the context of executive functioning which involves the deployment of attention in a goal-directed fashion based on complex relationships among stimuli in the environment. Further, little is known about how the neural networks associated with basic attention abilities 4 are related to those associated with executive functioning. The current project examines 2.5- and 3.5-year-olds basic attention and executive functioning during the Infant Orienting With Attention (IOWA) task that measures basic aspects of attention such as alerting and orienting and a Flanker task that measures selective and executive attention. Ocular-motor, behavioral, and hemodynamic responses (measured using functional near-infrared spectroscopy) were recorded simultaneously. Further, resting state functional connectivity was used as a novel method to identify the developmental status of intraregional and interregional connectivity between frontal and parietal attention networks. The strength of resting state functional connectivity within these networks, while passively watching videos during baseline, was predictive of event-related data and activation collected within each task. Children within both age groups were able to succeed in the Flanker, while age was predictive of the extent to which they succeeded. Functional connectivity rather than age predicted basic attention performance in the IOWA. Finally, the IOWA was sensitive to individual differences and predictive of selective attention during the Flanker. 1. Cuevas, K., & Bell, M. A. (2013). Infant attention and early childhood executive function. *Child development*, 85(2), 397-404. doi:10.1111/cdev.12126 2. Rothbart, M. K., Sheese, B. E., Rueda, M. R., & Posner, M. I. (2011). Developing Mechanisms of Self-Regulation in Early Life. *Emotion review: journal of the International Society for Research on Emotion*, 3(2), 207-213. doi:10.1177/1754073910387943 3. Veer, I.M., Luyten, H., Mulder, H., van Tuijl, C., Slegers, P.J.C. (2017). Selective attention relates to the development of executive functions in 2.5 to 3-year-olds: A Longitudinal Study. *Early Childhood Research Quarterly*, 41(1), 84 - 94 4. Posner, M. I., & Rothbart, M. K. (2018). Temperament and brain networks of attention. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 373(1744). <https://doi.org/10.1098/rstb.2017.0254>

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2-A-9 Relational reasoning is among the cognitive abilities that predict fraction understanding

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Prior work has linked better math performance, including fractions, with executive functions (EFs) (e.g., Geary, 2011; Siegler & Pyke, 2013). However, there is still variation in fraction performance to be explained. One often overlooked cognitive factor is relational thinking, the ability to consider multiple relationships among objects or mental representations, which has been argued to be relevant in the context of fractions (DeWolf, Bassok, & Holyoak, 2015; Miller Singley & Bunge, 2018). Critically, it is not known how relational thinking contributes to fraction understanding when canonical measures of EF are taken into account. The present study uses a simple relational matching task to investigate this question. Participants were 907 4th, 6th, and 8th graders from the San Francisco Bay Area. They completed many tasks, including fraction comparison, relational matching, math fluency, and a battery of 10 EF tasks, which were combined into three factor scores based on exploratory factor analysis (Younger et al., in prep). Using a linear model, we found that relational matching performance explained unique variance in fraction comparison performance even when controlling for math fluency and three latent EF factors (Figure 1). These findings highlight the importance of a basic, domain-general cognitive process--relational thinking--for mathematical achievement and support the need for further research on how to promote relational thinking in the context of math education.

2-A-10 Effects of sticky mittens vs. another interactive experience on infant object exploration

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Three-month-old infants who complete a 2-week at-home intervention with "sticky mittens" subsequently demonstrate more advanced object exploration behaviors compared to infants with no prior experience or with a passive object experience. In the current study, the effects of the standard sticky mittens intervention (n = 20) were compared with the effects of an interactive "Sing & Play" intervention (singing nursery rhymes with toys, n = 20) on infants' object exploration. We also tested the relations between infant temperament and/or motor skills and object exploration behaviors. Consistent with previous results, infants with sticky mittens experience touched a rattle more frequently (more separate touches) than infants with the interactive "Sing & Play" experience (W = 128.5, p < .05, r = -.31). However, unlike previous studies, there were no differences between conditions on the overall amount of time spent visually, manually, or orally engaging with toys. Parent reports of fine motor skills were related to the overall amount of time the infant spent manually engaging with toys, but no other parent-reported skills or temperament characteristics were related to measures of object exploration. These results are consistent with previous claims that sticky mittens experience uniquely enhances particular object exploration behaviors that may require more fine motor skills (e.g., frequency of touching). However, infant--parent interactions involving toys--both with and without sticky mittens--may promote infants' overall engagement with objects.

2-A-11 Visual-motor integration underlies preschool children's letter copying difficulties

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Letter recognition and letter production abilities provide the foundation for early literacy and future academic success. Handwriting involves the integration of cognitive, perceptual, and motor processes. The process through which children master handwriting is not well understood, however. To better understand handwriting development in early education, head-mounted eye-tracking was used to study children between the ages of 4 and 5 years ($N=25$) as they copied each letter of the alphabet. Eye and hand movements were recorded in real time to study visual attention and motor continuity during copying. Results indicated that errors in letter writing were related to children needing more time to write ($p < .05$). This extra time was spent looking back to the letter being copied more frequently ($p < .05$) and lifting the pencil more often during writing ($p < .05$). These data provide new information regarding the joint influence of visual and motor factors on the efficiency and success of handwriting in young learners.

2-A-12 Attentional decay: Implications for education

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Though 10 to 15 minutes is often considered the limit individuals can sustain attention, little empirical work supports this claim (Bradbury, 2016). The present study investigates the rate of attentional decay. Undergraduates ($N=28$) listened to a 20-minute geography screencast. Attention to the lesson was indexed with eye-tracking technology. The proportion of time fixating to the lesson was calculated for each minute of the screencast. A repeated measures ANOVA investigated whether attention changed as a function of time. Attention declined over time; $F(6.59, 177.84)=12.032$, $p<.001$. Pairwise comparisons indicate attentional decay at minute 15 ($M=.29$) compared to minute 1 ($M=.45$), $p<.001$. Importantly, reductions in attention occur before 15min ($M5Min=.41$; $M10Min=.39$ vs. $Min1$, $ps\leq.037$). Prior work found a quarter of elementary instructional activities exceeded 17.1 minutes (Godwin et al., 2016), which may be problematic given the observed attentional decay rates in college students. Work is underway examining attentional decay rates in elementary children.

2-A-13 Emotional facial expression preference in toddlers with Williams syndrome

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Williams syndrome (WS) is a rare neurogenetic, developmental disorder associated with a unique social-personality profile. Throughout development, individuals with WS show little to no stranger anxiety, approaching strangers much more readily than controls do. It has been hypothesized that their distinct tendency to approach strangers may be related to atypical processing of emotional facial expressions, particularly fearful or threatening expressions. Despite interest in the topic by researchers, to date, the effect of emotional valence on face processing in very young children with WS has never been explored. In the present study, we used a preferential looking task to examine the visual responses of toddlers with WS ($N = 12$, $\text{Mage} = 31.45$ months, $SD = 6.21$) to emotional facial expressions. Participants completed two blocks of six trials in which pairs of faces displaying different emotional expressions (all combinations of happy, angry, fearful, and neutral, counterbalanced) were shown side-by-side on a monitor for 10 seconds. Looking times were recorded offline. Results from the participants tested so far indicate a statistically significant preference for fearful over neutral ($Mdn = 10.5$ and $Mdn = 5.1$, $Z = -3.06$, $p < .0001$) and fearful over happy faces ($Mdn = 10.8$ and $Mdn = 6.1$, $Z = -2.51$, $p = .009$). Data collection

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is ongoing. Results will be discussed in light of a possible connection between emotional face processing, amygdala dysfunction, and stranger approach in WS.

2-A-14 Sentence comprehension in monolingual and bilingual children

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Bilingual children often outperform monolingual children on non-linguistic tasks that tap executive functioning but perform more poorly than monolinguals on tasks based on language proficiency. It is unknown how bilingual children perform on tasks that combine demands for both executive function and language proficiency. In the present study, two tasks that combined these processes were administered to 100 children (33 monolinguals, 67 bilinguals) between 4- and 5-years old. In the first task, children had to interpret the speaker's referential intent by integrating linguistic information with speaker's vocal affect. In the second task children were presented with four images that all contained the same elements but differed in terms of the relationship among and had to choose the picture that matched a complex sentence. As in previous research, monolinguals children scored higher than bilinguals on a test of English vocabulary. However, in both tasks bilingual children were more accurate than monolingual children in understanding the meaning of the spoken sentences in the presence of distraction. The results are discussed in terms of attentional control that allows bilingual children to more effectively focus their attention on the relevant information while ignoring other sources of information that interfered with the correct interpretation.

2-A-15 Interaction of bilingualism and socioeconomic status in children's executive function performance

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Previous research has shown that both bilingualism and socioeconomic status (SES) predict Executive Function (EF) performance in children. We investigated the interaction between these two predictors on performance in an EF task, the Simon Picture Task, in 234 six-year-olds. Children learned the mappings between four stimulus pictures and a response key and had to indicate the correct response when the key position was the same as the stimulus presentation (congruent trials) or not (incongruent trials). Bilingualism was measured on a continuous scale of degree of bilingual experience and then categorized using a median split on this measure. SES was measured in terms of parents' education and again used both continuously and categorically using a median split. Analyses based on the categorical variables showed a main effect of SES and an interaction between bilingualism and SES on RT performance, with better performance by bilinguals in the high SES group but no language group differences in the low SES group. Using continuous measures in a regression analysis, bilingualism was significantly related to reaction time, with higher levels of bilingualism associated with faster RT across the whole sample. There was no continuous effect of SES. Results are discussed in terms of interactions between bilingualism and SES on EF performance.

2-A-16 The neural underpinnings of variability in the development of category learning

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Variability is often viewed as being beneficial in highlighting the relevant features required in object categories. This is useful for children who tend to form categories with relevant and irrelevant features. The development of neural underpinnings of perceptual variability in categorization, however, is not known. We hypothesized that variability will shift object membership to consistent features among exemplars, as reflected by increased ventral temporal cortex activity. Adults and eight-year-old children completed an fMRI-adaptation paradigm in which they were habituated to tightly or variably organized categories. Representations were probed with stimuli that differed on either a consistent or variable feature. In adults, variability recruited the right fusiform to a greater extent than similar exemplars, $p < .01$, $pcor < .001$, but no region demonstrated this effect in children. For generalization, we conducted a $2 \times 2 \times 2$ ANOVA with adaptation release. There was no significant three-way interaction, but there was a significant interaction between Exposure and Probe associated with the left fusiform, $F \geq 7.77$, $p < .01$, $pcor = .001$. This interaction was spurred by a greater release to variable changes when exposure was tight, but a greater release to consistent information with variability. Thus, tight and variable experience similarly affect children and adults. However, different exposures lead to divergent neural responses regarding category representations.

2-A-17 Better with age: The progression of accurate performance perceptions

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Children's ability to evaluate their own competence can predict their motivation, effort, cognitive engagement in tasks, and school performance (Bouffard, Markovits, Vezeau, Boisvert & Dumas, 1998). Previous research shows younger children exaggerate their own abilities; however, as they get older, these self-perceptions become more accurate (Stipek, 1981; Wentzel & Wigfield, 1998). Proposed theories indicate that the increase in accuracy of self-perceptions is due to changes in cognitive processes (i.e., development of metacognitive skills and integration of past performances) and environmental factors (i.e., use of feedback) (Stipek & Iver, 1989). However, it is still unclear when these changes occur. Children (6-9 years) completed a 10-minute sustained attention (SA) task and then rated their own performance. We computed an Accuracy index using children's ratings of perceived performance divided by objective performance (d'). Although children in the younger ($n=41$, $M=50.81$, $SD=16.59$) and older ($n=43$, $M=56.36$, $SD=19.71$) groups performed similarly on the task ($p=0.165$), the younger ($M=86.86$, $SD=23.33$) compared to the older ($M=69.42$, $SD=30.57$) children were more likely to report better performance on the task ($p=0.004$). As age increases, the Accuracy index decreases towards 1, becoming more accurate ($r=-0.267$, $p=0.014$). Overall, 6 and 7-year-olds tend to overestimate their SA performance compared to 8 and 9-year-olds, who exhibit more realistic ability beliefs.

2-A-18 Explaining developmental shifts by competing cognitive states

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Sudden shifts in behavior are frequently observed in learning and development. In category learning, sudden shifts are observed between rule-based and overall-similarity based representations (Raijmakers et al 2014, Visser & Raijmakers, 2012). In cognitive flexibility research, using the DCCS task, a sudden shift is observed between perseveration and correct responding (Van Bers et al 2011). In the balance scale task, participants differ in their use of rule-based versus information-integration strategies (Hofman et al 2015) and show sudden shifts between using different strategies (Jansen et al, 2007).

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Similar strategic differences are found in childrens' performance in multiplication problems (Hofman et al 2018). Dual or multiple systems models are often invoked in explaining such results. For example, exemplar-based memorization processes are competing with explicit rule-based processes in category learning. Similarly, implicit memory of previously sorted items are competing with new sorting rules in children performing on the DCCS task (Van Bers et al 2011). Children performing in the balance scale task show evidence of a competition between ignoring versus attending to specific features of the task (Jansen et al, 2007). At a different level, children performing in the balance scale task show competition between applying rational, effortful strategies, versus relying on rather more associatively learned reward-based responses (Hofman et al 2015). Here we present 1) a common theoretical framework to explain the dynamics of switching between such dual systems or competing cognitive states, 2) the methodology required for recognizing and detecting sudden shifts between them, and 3) how this can help identifying the variables of interest that drive shifting between competing cognitive states - that is, the factors that drive learning and development. Dynamical, competitive models are shown to be very versatile models in explaining learning and cognitive development and can help integrating results from a wide variety of different experimental paradigms by showing that similar underlying mechanisms are at play in producing the phenomena of interest. BMCW van Bers, I Visser, TJP van Schijndel, MEJ Raijmakers - *Developmental Science*, 2011 AD Hofman, I Visser, BRJ Jansen, HLJ van der Maas - *PloS one*, 2015 AD Hofman, I Visser, BRJ Jansen, M Marsman, HLJ van der Maas - *Learning and Individual Differences*, 2018 BRJ Jansen, MEJ Raijmakers, I Visser - *Synthese*, 2007 MEJ Raijmakers, VD Schmittmann, I Visser - *Cognitive psychology*, 2014 I Visser, MEJ Raijmakers - *Frontiers in psychology*, 2012

2-A-19 Associations among symbolic functioning, joint attention, expressive communication, and executive functioning of children in rural areas

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This study examined developmental pathways from symbolic functioning to executive functioning among young children who lived in rural areas of the United States. We tested a model including both a direct pathway from symbolic to executive functioning, as well as an indirect path through joint attention and expressive communication. Data used in the present study were collected by the Family Life Project during the second and third year of these children's lives. One thousand and eight children were included in our analysis. Structural equation modeling was used to test the hypothesized model. The fit indices suggested a good model fit, $\chi^2(22) = 38.406$, $p = .0165$, CFI = .959, TLI = .975, and RMSEA = .027. Children's symbolic functioning at 15 months was found to be positively predictive of children's executive functioning at 35 months. The effect of symbolic functioning at 15 months on executive functioning at 35 months through children's proportion of joint attention during shared reading at 24 months, children's expressive communication at 24 months, and children's expressive communication at 35 months was significant. These results indicated that children's early symbolic functioning during the second year was related to executive functioning by the end of the third year, and that an underlying mechanism including children's joint attention and expressive communication can be considered when explaining this relationship.

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B – Memory and reasoning

2-B-19 The development of visual working memory over the second year of life

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Visual working memory (VWM) skills emerge early, and are critical for nascent cognitive abilities and later academic achievement. Here we used the Delayed Match Retrieval paradigm (Kaldy et al., 2016) on an eye-tracker to investigate infants' VWM development over their second year. 30 participants (13 females) were tested at 15 months of age, and again when they were 20 months old. In both experiments, participants were tested to remember two object-location bindings on screen. Preliminary results showed overall performance was at chance at Visit_1 (45% correct, $p > 0.05$) but significantly above chance at Visit_2 (56% correct, $p = 0.019$). We also found a significant age-related increase in performance ($r = 0.24$), but no significant individual stability ($r = 0.03$). Interestingly, the correlation between number of completed trials at Visit_1 and Visit_2 was marginally significant ($r = 0.36$), suggesting that task persistence is stable at the individual level. Data collection from Visit_3 (at 24 months) is ongoing.

2-B-20 The socialization of children's autobiographical and deliberate memory through parent-child reminiscing

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There exists a sizable literature on the socialization of children's cognition, highlighting associations between mother-child reminiscing and the development of young children's autobiographical memory (see Fivush, Reese, & Haden, 2005). However, there is still quite limited understanding of the role of mother-child reminiscing in the facilitation of children's deliberate memory. In an ongoing longitudinal study, we assessed parent-child reminiscing as it relates to children's memory and cognitive skills. Fifty-one children entering kindergarten (49% female, 65% Caucasian, 35% students of color), drawn from 3 schools, were assessed with a battery that included both autobiographical and deliberate memory tasks. In a parent-child reminiscing task (Reese, Haden, & Fivush, 1993), parent-child dyads discussed two jointly-experienced events, and parents were categorized as higher or lower in their use of elaborative language. Preliminary analyses highlight the association between parents' elaborative style and kindergartners' recall in an Object Memory task ($F = 4.231$, $p < .05$). These and other results will be presented in order to highlight further the role of parental socialization of both deliberate recall and the use of deliberate strategies for remembering.

2-B-21 What did you see at the zoo this week? Examining free recall of naturalistic events in early to middle childhood

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Episodic memory (EM) is memory for past events from a particular time and place. Free recall measures, in which participants study and recall word lists, are prominent in the adult EM literature. This work has shown patterns in the order in which events are recalled (e.g., temporal clustering, semantic clustering). Relatively little is known about free recall in children. Further, previous studies in the child and adult

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memory literature often use word or object-based study lists, learned and tested in one day. The present research is a naturalistic study in which children experienced engaging events across a week. Participants were 4- to 10-year-olds ($N = 147$) who took part in a 5-day camp at a local zoo. Children visited various animals every day, according to a predetermined schedule. On day 5, children were asked to recall the names of all the animals they visited during the week. We found age-related improvements in the number of animals recalled, $F(2, 144) = 37.58, p < .0001$. Four to 5-year-old children ($M = 5.76, SD = 4.49$) recalled fewer animals than 6- to 7-year-olds ($M = 10.57, SD = 6.0$), and 6-7-year-olds recalled fewer animals than 8- to 10-year-old children ($M = 17.96, SD = 9.40$). In addition, we examined recall clustering effects (e.g., temporal clustering), using children's individual camp schedules. These additional results, and implications of this work to our understanding of EM development will be discussed.

2-B-22 Multitasking abilities in 7- to 10-year-old children

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The ability to monitor and coordinate several tasks at once has become increasingly important in modern lives; yet, amazingly little is known about its development. In this cross-sectional study, we investigated the development of multitasking abilities in children between 7 and 10 years of age ($N = 93$), and we explored possible contributing variables. Children solved several tasks on a touch-screen measuring multitasking, visuo-spatial working memory, sustained attention, and executive functioning (i.e., task switching and mixing costs). Multitasking was measured with a novel task, in which children were presented with up to four different counters that ran at different paces. Children were asked to press a button whenever a counter had reached the end of its cycle. After a first block of open trials, the counters were covered, but children were able to lift the occluders individually to monitor the progress of each counter. Performance was scored in terms of how many temporal deadlines children met by pressing the respective button within the last 20% of the cycle. Regression analyses showed that a significant part of the variance in children's multitasking performance was explained by age. In addition, variance in multitasking performance was explained by visuo-spatial working memory. A repeated measures ANCOVA yielded significant main effects of Age, Number of Tasks, and Occluder, as well as interactions of Age x Number of Tasks, Age x Occluder, and Age x Occluder x Number of Tasks (all p s $< .05$). Detailed analyses showed that multitasking performance increased significantly from age 7 to 9, but there was no notable improvement between 9 and 10 years of age. High working memory capacity was especially helpful when observing four counters as compared to two or three. In fact, performance of 9- and 10-year-olds with high working memory capacity was hardly affected by an increase in the number of counters, as long as they were not occluded. In contrast, performance of children with low working memory capacity decreased with increasing number of tasks in the open and occluded conditions. These findings indicate that children's ability to juggle two or more tasks simultaneously develops considerably until the age of about 9 years and is associated with improvements in working memory capacity. Multitasking likely requires additional processes compared to dual tasking, and thus deserves separate attention in cognitive and developmental research.

2-B-23 Children fail to show that they can reason by the disjunctive syllogism until the age of 5

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In a typical task investigating reasoning by the disjunctive syllogism, a reward is hidden within one of two cups (i.e., A or B), and subsequently one cup (e.g., A) is shown to be empty (e.g., Call, 2004). Children should then logically infer that the alternative cup (B) is the one containing the reward (i.e., "A or B, not A, therefore B"). However, in these tasks children may also pick the correct cup without such reasoning, for instance by simply avoiding the known empty cup. Mody and Carey (2016) attempted to control for this possibility with a paradigm that involved two pairs of cups (i.e., cups A and B; and cups C and D). In this design two stickers are hidden, one sticker in cup A or B, and one sticker in cup C or D. The authors argued that when one cup was shown to be empty (e.g., A), children who could reason by the disjunctive syllogism should choose the alternative cup within that pair (i.e., B, where a sticker definitely is), rather than searching either cup from the other pair of cups (i.e., C or D, since the location of this sticker is still unknown). They found that 3-, 4- and 5-year-old children succeeded at this task. However, although Mody and Carey (2016) argue that this design eliminates the possibility of children simply avoiding the known empty cup, we contend that it does not. Specifically, children could also have succeeded in this paradigm by avoiding the known empty cup within each pair of cups (i.e., avoid A but choose the other cup in that pair) and disregarding the alternative pair altogether (i.e., disregard C and D). This type of responding would result in success without reasoning by the disjunctive syllogism. Therefore, in the present study we included two conditions: The 'show empty' condition was a conceptual replication of Mody and Carey's (2016) original four cup task; and a new 'remove sticker' condition, where children would fail if they simply avoided the known empty cup within a pair. In this novel condition, a sticker was removed by the experimenter from one pair of cups (i.e., A). Therefore, in order to have a chance of finding the second sticker, children needed to search within the alternate pair of cups (i.e., A or B, A, therefore not B; therefore choose C or D). Our sample included 2.5-, 3-, 4- and 5-year-old children (N = 100). Replicating Mody and Carey's (2016) finding, all age groups performed above chance on the original four cup task. However, in the novel 'remove sticker' condition, only 5-year-old children performed above chance, whereas 2.5-, 3- and 4-year-olds did not. There are several possible explanations for this findings. Firstly, and as we hypothesised, children might actually be avoiding the empty cup within a pair. This would result in earlier success in the original "show empty" condition, but failure in the "remove sticker" condition. Secondly, children in both conditions might be picking a cup by using a 50/50 strategy; that is, choosing at chance between each pair (i.e., A/B or C/D) rather than considering each cup individually. Finally, children might be struggling to disengage from the pair of cups that is manipulated by the experimenter (i.e., when a cup is shown to be empty or when a sticker is removed), resulting in a bias to choose from the same pair. Importantly, our results ultimately suggest that Mody and Carey's (2016) conclusion that 3-year-olds can reason by the disjunctive syllogism may be premature.

2-B-24 Information-seeking as implicit uncertainty monitoring in childhood

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Children are notoriously 'overconfident' about their judgments under uncertainty, and often express high confidence in cases where they are likely to be incorrect. On the other hand, children tend to preferentially explore what is ambiguous and uncertain from an early age, suggesting they may have implicit awareness of the unknown (Hembacher & Ghetti, 2014). Here, we compare children's explicit judgments to their implicit awareness of uncertainty expressed in information-seeking behavior. Three-, four-, and five-year-olds saw three "windows" that ranged in occlusion (none, partial, and full). When

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asked to report their confidence that each window contained a target shape using a 3-point scale, 5-year-olds gave significantly lower ratings for the fully occluded than clear window, $t(66.13) = 1.0$, $p < 0.001$, but 3- and 4-year-olds showed no difference in confidence ($p = 0.7876$ and $p = 0.549$, respectively). However, when children of the same age were asked which window to open in order to learn more about the shapes inside, both 4- and 5-year olds showed a strong preference for the fully occluded window (62.5% and 63.6% of choices, respectively). This study is the first to connect uncertainty monitoring to information search in early childhood, and results suggest that sensitivity to the presence of uncertainty might serve as an early precursor to children's explicit judgments.

2-B-25 Children's racial essentialism predicts facial recognition memory performance

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This study examines the relationship between racial essentialism and facial recognition memory in a sample of children of color, aged 5-12 years old. Children completed Oddity Triads, with one same-race option and one different-race option and had to choose which adult a target baby would grow up to or which family that baby would be a part of. They were also shown same-race and different-race pairs of children and were asked whether the two could "share the same insides" or be brother and sister. Children were asked to give open-ended explanations for their binary choices. Analyses show that 89% of children explicitly reference skin tone, and nearly 66% demonstrated essentialist-consistent language in at least one of their responses. Across the entire sample, memory performance was significantly higher for Black target faces than White, Asian, or Hispanic targets ($F(3) = 4.935$, $p = .002$), demonstrating an Own-Race Bias similar to what has been shown by White children. Critically, children's racial essentialism predicted their facial recognition memory performance, whereby higher essentialist beliefs on the "shared insides" question were associated with more memory errors, $r(73) = -.249$, $p = .034$. The relationship between racial essentialism and facial recognition memory suggests racial essentialism has important downstream consequences on other cognitive processes from early in development.

2-B-26 Developmental changes in future-oriented explanation search

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How does the capacity to use future goals to guide learning emerge? In the present research, we investigate whether learners preferentially seek explanations they expect to generalize to a future goal. Adults ($N = 21$) and 4- to 7-year-olds ($N = 29$) were shown robots with light-up antennae, which illuminated when a robot was fed its preferred category of food. Participants were taught a general rule through demonstration and verbal report: robots with the same color (or with the same pattern) eat the same food. Participants were shown a "target" robot, with novel color/pattern, that they would later feed. Then, two robots with illuminated antennae were revealed, one matching the target in pattern and one in color. After being prompted to ask why one robot had illuminated, most adults (90%) but fewer children (52%) sought the explanation that would generalize to the target, $p < .05$. Only 38% of children who sought this explanation (versus 100% of adults) fed the learning target the correct food category, but children's generalization success increased with age ($OR = 2.71$, $p = .08$), suggesting that older children may be better able to capitalize on information gained for future use. These results, along with ongoing work, suggest that using future goals to guide learning is challenging for young children.

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Finding a shift from undirected explanation search to search geared towards future generalization could have important implications for understanding curiosity and learning.

2-B-27 The development of children's understanding of argument by analogy

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Analogical reasoning allows humans to make inferences about novel experiences and transfer learning across contexts. There is substantial literature on how analogical reasoning develops, but less is known about how children understand a common use of analogy--argument by analogy. Considering the importance argument by analogy plays in politics and the law, we examined the developmental trajectory of the ability to understand arguments by analogy. We measured children's (N = 128, ages 3-12 years old) performance on a commonly used analogical reasoning task (i.e., a picture-mapping task; see Richland et al., 2006) and their understanding of arguments by analogy. We found that at age 4, children have as much difficulty understanding arguments by analogy as they do performing a picture-mapping task. However, by age five, children's performance improves more rapidly in an argument by analogy task compared to a picture-mapping task.

2-B-28 Context-dependent differences in spontaneous relational reasoning use in relationally focused four-year-old children

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Relational reasoning underlies the ability to recognize structural similarities across relationships, but ensuring young children attend to these similarities is difficult. This study examined contextual factors influencing children's spontaneous relational reasoning, or the likelihood of identifying relational similarities when unprompted. 30 four-year olds first completed an ambiguous scene analogy task (ASA) consisting of pairs of scenes depicting the same relationship in different contexts, adapted from Richland, Morrison & Holyoak (2006). Children selected an object in the second scene that "goes with" a highlighted object in the first scene, choosing from objects relationally or perceptually similar to the highlighted object. Next, participants completed 4-item visual matrix analogies (MA), selecting and explaining their rationale for why a perceptual, relational, or identity option "best finished" each matrix. Last, participants distinguished between actual and slightly altered ASA images in a memory task (MT). Controlling for age, ASA relational choices negatively predicted ($\beta = -0.73$, $p < .05$) MA relational strategy use. Also, ASA relational choices negatively predicted ($\beta = -0.45$, $p < .01$) while perceptual choices ($\beta = 0.26$, $p < .05$) positively predicted MT accuracy, suggesting that more relationally focused children processed ASA images less perceptually. These findings suggest adaptive, context-dependent rationales for object-based versus relational strategy use.

2-B-29 Children's reasoning about hypothetical interventions to complex biological systems

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What would the world be like with no bees? Counterfactual thought experiments of this form can help drive scientific theories and policy debates. At what age can children engage in such thought experiments by considering hypothetical interventions to complex and dynamic causal systems? We

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presented 5- to 7-year-olds with novel food chains containing three species and asked them to consider the effect of removing one species on the other two. Children answered questions about the effects of species' removal on direct predators, direct prey, indirect predators, or indirect prey. In Exp 1 (N=72), children were significantly more accurate when answering questions about directly-connected animals than indirectly-connected ones ($p = .009$). Whereas 5-year-olds' performance did not exceed chance on any question types, 6- and 7-year-olds answered questions about direct effects with a high degree of accuracy ($p < .001$, binomial tests). In Exp 2 (N=72), we replicated the main findings with a new set of stimuli, but also found that 6- and 7-year-olds' performance was significantly better than chance when reasoning about indirect effects ($p < .001$, binomial tests). These results suggest that children can consider hypothetical interventions to complex and dynamic causal systems between the ages of 5 and 7. Implications for theoretical models of causal learning and for science education will be discussed.

2-B-30 Intuitive statistics and metacognition in children and adults

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¹MIT

Across six experiments, we asked whether participants represent the relative difficulty of discrimination problems and systematically ask for more samples as populations become harder to discriminate. To test this, we showed participants two populations of balls and asked them how many balls they would need to see in order to know which of two populations the sample was drawn from (see Fig. 1). Critically, participants never saw any samples, so they had to make a priori, metacognitive judgments rather than just asking for more samples when they were uncertain. Adults successfully requested larger samples for more difficult discriminations across ten discriminability contrasts (ranging from 90/10 vs. 10/90 to 49/51 vs. 51/49; order randomized) both when there was no explicit cost of sampling (Exp. 1: N = 30) and when there was (Exp. 2: N = 30). When given the option to skip questions, adults preferentially skipped the most difficult discrimination problems (Exp. 3: N = 50; Exp. 4: N = 50). Six- to eight-year-olds (Exp. 5: N = 24, M = 7;6, range: 5;11-8;11; Exp. 6 (pre-registered replication): N = 24, M = 7;2, range: 6;1-8;10) succeeded both in a simplified version of the task and in a version nearly identical to the adult task. The results suggest that both adults and children perform "intuitive power analyses": they represent the degree to which populations overlap and ask for more samples when trying to distinguish less discriminable populations.

2-B-31 Infants and preschoolers do not use new evidence to retrospectively reinterpret an expected event as surprising

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Infants detect events that end in surprising outcomes. Yet some events' outcomes initially seem ordinary, but in light of subsequent information are actually surprising. Detecting these requires retrospective reinterpretation—an ability whose development is unknown. We examined retrospective reinterpretation by showing 1- and 3-6-yr-olds a ball roll down a path blocked by a wall. They either saw the ball stop in front of the wall (Expected) or on the wall's far side (Surprising). Next the wall was rotated, revealing it either was solid or had a large opening in it. The opening provided an explanation for children who saw Surprising outcome, but conflicting information for those who saw the Expected one. Infants who saw the ball pass through the wall with no explanation explored the ball over a novel distractor. They also successfully used new evidence to revise their construal of this initially surprising

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outcome: those who saw an explanation for the surprising event (wall w/ hole) showed no exploratory preference. Critically, infants failed to revise an outcome initially seen as expected. Those who saw the Expected outcome followed by new evidence rendering that outcome impossible (wall w/ hole) showed no exploratory preference, indicating lack of surprise. In a parallel paradigm we found that 3- and 4-yr olds also failed to revise their construal of an expected event, whereas 5- and 6-yr olds succeeded (Fig. 1). Hence retrospective event reinterpretation develops slowly.

C – Spatial and numerical knowledge

2-C-32 How do 3rd-grade children understand the commutative principle of multiplication?

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School-age children learn the basic rules of arithmetic and implicitly experience some of their properties, such as commutativity. These properties are often taught as calculation strategies and are thus intrinsically tied to symbolic calculation. As a result, children's knowledge that 2×3 equals 3×2 may only reflect a shallow understanding of commutativity. In the present study, we investigated 3rd-graders' understanding of commutativity in symbolic versus non-symbolic contexts, and we assessed their corresponding brain activity in both passive and active tasks. During an fMRI scan, 18 children watched a pedagogical movie about the commutative principle of multiplication and completed a same/different task on pairs of symbolic operations or "groupitized" dot arrays. Some pairs directly tested commutativity (e.g. 2×3 vs 3×2) while other pairs used different operations (e.g. 2×3 vs 4×2) or different numbers (e.g. 2×3 vs 2×4). As expected, children proved to master commutativity in symbolic contexts more than in non-symbolic contexts. However, after training, their performance in non-symbolic contexts significantly improved compared to a group of children trained on a grammar lesson. At the brain level, using the original inter-subject correlations technique, we showed that both passive viewing and active manipulation of commutativity-related content elicited similar activation in children's right intraparietal sulcus, at a site commonly associated with math processing.

2-C-33 The role of fraction understanding in middle school profiles of algebra learning

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Fraction knowledge and algebraic skill are closely linked (Brown & Quinn, 2007), with fraction knowledge and magnitude understanding particularly predictive of later algebra knowledge in adolescents (Booth & Newton, 2012; Siegler et al., 2012). Recent work narrowed in on specific algebraic skills related to fraction magnitude knowledge, which include equation solving, feature knowledge, and encoding of algebraic equations (Booth et al., 2014). Using a person-centered approach (LPA), we build upon prior work to consider a host of algebra skills (equivalence, equation solving, word-problems, encoding of equations) simultaneously to develop latent profiles of middle school students' algebra understandings. Using Latent Transition Analysis (LTA), we fit a developmental model of algebra understanding across two time points (Start-of-Year-SOY, End-of-Year-EOY) and determine the role of a range of fraction skills (number line estimation, magnitude comparison, word problems, computations, broad concepts) and demographic covariates in these transitions. Middle school students (N=350) from diverse public schools in the Northeast United States completed a series of fraction and algebra measures at the start and end of the school year. Underrepresented minority (URM) students made up

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26% of the sample. URM students included Black (49%), Latinx (35%), biracial (12%) students, and 3% were other ethnicities. The first step of our analyses - latent profile analyses on the start-of-year algebra readiness measures - is complete thus far. A bootstrapped likelihood ratio test (BLRT) revealed that a three-profile model fit significantly better than a two-profile model ($2\Delta LL=121.13, df=5, p<.0001$). The entropy statistic was high (.85) indicating that the three latent profiles were distinct. The mean conditional probabilities of profile membership for the three-profile solution were also highly satisfactory (.94/.96/.91) with a lower BIC (-216.74) than the two-profile solution. A BLRT comparing the three-profile to the four-profile model was not significant, indicating no improvement of fit when moving to four-profiles. Profile 1 (Low Understanding, $n=174$; 49.7%) was the largest and was characterized by low algebra skills across the board. This included low means on the conceptual measure that mainly targeted equivalence ($M=42.1\%$) as well as low performance on word problems ($M=8.6\%$), equation solving ($M=5.2\%$) and encoding of equations (9.6%). Profile 2 was the smallest (High Understanding, $n=49$; 14%) and characterized by high conceptual understanding on the equivalence measure (78.4%) and high equation-solving skills (83.4%) as well as relatively high scores on word problems (42.5%) and encoding (44.8%) in comparison to profile one. Profile 3 (Mixed Understanding, $n=127$; 36.3%) was the second largest and was similar in conceptual scores (63.9%) and equation solving ($M=37.1\%$) as profile 2 but had relatively low scores on word problems ($M=33.9\%$) and encoding ($M=15.5\%$). The next step in this analysis is to use LTA to assess the probability of transitioning from one algebra profile at SOY to another at EOY. We will also assess the role that fraction understanding plays in algebra learning by assessing whether and which SOY fraction understandings predict these transitions. These findings will have important practical implications in considering which fraction skills should be targeted for remediation that may lead to improvements in algebra understanding.

2-C-34 Size versus number: Children's early understanding of number words

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This study investigates when children begin to understand that individual number words (e.g., one, two...) refer to discrete numerosity, as opposed to continuous spatial extent. Over 50 children (2- to 4-year-olds) completed three tasks: Transform Sets (adapted from Sarnecka & Gelman, 2004), Give-N (Wynn, 1992), and a measure of executive functioning. For the Transform Sets task, children viewed an array of items on a computer screen ("Look, there are five shoes!"). The set then 'transformed' in some way, prompting a follow-up question ("Now, are there five or six shoes?"). For some trials, one item was either added or removed from the set, thereby introducing a transformation in both numerosity and continuous spatial extent. For other trials, the items grew or shrank by 50%, resulting in a transformation of continuous quantity, but not numerosity. Findings show that children who know the meanings of at least three number words (i.e., 3-knowers), understand that number labels change only if an item is added or subtracted from the set, $F(2,12)=5.22, p=.02$. Children who know just one or two number words (i.e., 1- and 2-knowers) are just as likely to think that the number label changes when items grow or shrink, $F(2,16)=.32, p=.58$. In fact, 1-knowers seem more inclined to change number labels in response to manipulations of size versus numerosity. Performance on the Transform Sets task is best predicted by knower-level, rather than age or executive functioning skills.

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2-C-35 Spatial skills, but not spatial anxiety, partially account for the gender gap in number line estimation

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Number line estimation (NLE) is a well-known predictor of later math achievement. In prior work, boys usually outperform girls on number line tasks. Researchers have theorized that this gender difference could be due to gender differences in spatial anxiety or spatial skills. We empirically tested this theory among children from Kindergarten to 4th grade ($N = 495$; 275 girls). Children completed age-appropriate measures of NLE, spatial anxiety, mental rotation, and proportional reasoning. We standardized scores within grade-level for each task. Consistent with previous literature, boys surpassed girls in NLE, $t(399) = 5.79$, $p < 0.001$, $d = 0.56$. Furthermore, compared to girls, boys had lower spatial anxiety, $t(361) = 2.01$, $p = 0.045$, $d = 0.21$, higher mental rotation, $t(418) = -2.29$, $p = 0.022$, $d = 0.22$, and higher proportional reasoning scores, $t(447) = 2.16$, $p = 0.031$, $d = 0.20$. In a simultaneous mediation model, mental rotation and proportional reasoning significantly mediated the relation between gender and NLE (95% CIs with bias-corrected bootstrapping = $[-0.06, -0.003]$ and $[-0.11, -0.003]$, respectively), but spatial anxiety did not (95% CI $[-0.04, 0.01]$). A significant direct effect of gender on NLE remained in the model. Thus, spatial skills, but not spatial anxiety, partly explain the gender gap in NLE during this developmental period. Future research should investigate additional potential mechanisms, such as estimation skills or number line strategy preferences.

2-C-36 What's in a question? Parents' questions in dyadic interactions and the relation to 4-year-old children's math abilities

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The complexity of adults' questions, particularly during book reading, supports children's developing language skills. Question complexity can be described as low-level (e.g., labeling, matching) or high-level (e.g., comparing, predicting). Little is known about how parents question in different contexts and the relation to children's math abilities. The present study examines the quantity of low- and high-level questions that parents pose to children across three activities, and how the frequency of questions relates to children's concurrent math skills. Parent-child dyads ($n=43$) were observed interacting with a picture book, grocery store toys, and a puzzle for ~5 min each and children completed math and spatial assessments. A 2-way rm-ANOVA revealed that parents asked significantly more questions in the book task ($F(2, 252)=24.26$, $p<.01$) and more low-level questions in all tasks ($F(1, 252)=74.4$, $p<.01$). More low-level questions in the puzzle task were negatively related to children's number skills ($r=-.37$, $p<.01$) and approximate number system acuity ($r=-.41$, $p<.05$). Frequent high-level questions in the book task were positively related to children's spatial skills ($r=.35$, $p<.01$) and standardized math scores ($r=.46$, $p<.01$). This study can inform interventions aimed at promoting early math learning. Future analyses will control for the number of utterances in these conversations, correlate question use with children's language skills, and examine math-specific questions.

2-C-37 What cues do children use when judging their confidence in fraction estimation performance? Confidence judgments relate more strongly to familiarity than performance

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According to cue-utilization theory (Koriat, 1997), people should use diagnostic cues to accurately monitor their performance. When monitoring fraction magnitude estimation performance, which predicts math achievement (Siegler et al., 2012), adults rely on a less diagnostic cue--familiarity with fractions--to make trial-by-trial confidence judgments (CJs) when estimating small- (e.g., 3/4) and large-component (e.g., 12/16) equivalent fractions on number lines. Adults were more confident and familiar with small- relative to large-component fractions, even though their estimates were equally precise. We extended these findings to a sample of elementary school students ($N=70$, $Mage=10.45$, $SD=.58$; 38 females). Children also estimated small- and large-component fractions with equal precision, $F(1,68)=1.39$, $p=.13$, $\eta^2=.03$, even though small- compared to large-component fractions were rated as more familiar ($F[1,68]=117.92$, $p<.001$, $\eta^2=.63$) and estimated with more confidence ($F[1,68]=63.19$, $p<.001$, $\eta^2=.48$). The difference in confidence between equivalent fractions was larger for older ($Mdif=.59$, $\eta^2=.45$) than younger ($Mdif=.29$, $\eta^2=.17$) children, suggesting additional fraction experience may bias confidence. Children's familiarity was a stronger cue for making CJs than their actual accuracy ($\eta^2=.29$; see Figure). Thus, experience with fractions leads to overconfidence and misuse of cues when monitoring performance, which may negatively impact study decisions and error monitoring.

2-C-38 Detecting and addressing faulty reasoning about fraction magnitude

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Student learning can benefit from making and discussing errors (Metcalf, 2017). Yet preservice teachers (PST) have difficulty evaluating mathematical explanations and addressing errors (Morris, 2007). As many students struggle to develop fraction magnitude understanding (Siegler et al., 2013), teachers are likely to encounter frequent student errors in this area. We examined PSTs' ability to successfully detect and address fictitious students' errors on fraction comparison tasks. Participants ($N=32$) studied and explained fictitious students' faulty reasoning on a fraction comparison task. We compared whether PSTs' skills in error detection and addressing these errors varies by the strategy used by fictitious students to compare fractions (Figure 1. Distance-to-one; Common numerator strategy; Benchmark to one-half). PSTs were significantly more successful at detecting errors made with the common numerator strategy ($M=63.3\%$) than those made with distance-to-one ($M=43.3\%$) and benchmark to one-half ($M=22.2\%$) strategies ($ps<.001$). PSTs addressed significantly more common numerator (77.8%) and distance-to-one (67.8%) errors in their explanations than benchmark to one-half (38.5%) errors ($p<.001$). On a scale of 0-2, PSTs' scored an overall rating of $M=1.79$ ($SD=0.05$) in their quality of explanations of errors addressed and quality did not vary by strategy. Findings suggest PSTs need support in detecting and addressing students' faulty knowledge of fraction magnitude.

2-C-39 Visually scaling distance from memory: Do visible boundaries make a difference?

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The goal of this project was to understand the strategies 4- and 5-year-old children and adults use to visually scale distance by testing whether visible boundaries make it easier to scale larger distances. Participants watched as an object was placed on a learning mat and then attempted to place a replica object on a test mat that was either identical (no scaling task) or different in size (scaling task). In Experiment 1, children and adults scaled up from 16 to 64 inches or down from 64 to 16 inches with no

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boundaries present. Consistent with the perceptual anchoring hypothesis, both children and adults had difficulty scaling up but not scaling down. In Experiment 2, children and adults scaled up from 16 to 64 inches or down from 64 to 16 inches with a visible midline boundary present on both the learning and test mat. We expected that including visible boundaries would reduce absolute error when scaling up if children and adults were using a proportional reasoning strategy but would have little effect if they relied on a mental transformation strategy. Children and adults again had difficulty scaling up but not scaling down, suggesting that they may rely on a mental transformation strategy to scale visual distance. These findings underscore the importance of test mat size in visual scaling, providing further support for the perceptual anchoring hypothesis.

2-C-40 Do actions speak louder than words? Measuring children's focusing on number

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Spontaneous focusing on numerosity (SFON) measures children's tendency to focus on numerical information without being prompted and has been linked to later math abilities (Hannula & Lehtinen, 2005; Hannula et al., 2010). In typical SFON tasks, children see an experimenter perform a number of actions (e.g., feeding a puppet three berries) and are asked to imitate her. Past work utilized various methods of quantifying children's SFON, yet has not directly compared non-verbal and verbal behaviors (e.g., accurately imitating the number of actions vs. talking about number). Here, we investigated individual differences in the speech and actions of children performing different SFON tasks. 129 four-year-old children completed four imitation and modeling tasks, adapted from Hannula & Lehtinen (2005), over two visits approximately two months apart. Children were coded as focusing on number through speech if they verbally referenced number or quantity and coded as focusing on number through action if they accurately recreated the set size. Within each of the four tasks, no correlations were observed between children's speech and actions. However, children who focused on number in one modality during one task tended to focus on number in that same modality for other tasks (speech across tasks: $r=0.27$; action across tasks: $r=0.29$; see Table 1). These findings suggest measures of SFON should encompass both speech and action to accurately measure children's spontaneous focusing on number.

2-C-41 Visual comparisons in STEM textbooks: Frequency of supports for aligning relational structure

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Visualizations, such as diagrams, photos, and graphs are useful for conveying complex concepts and relational structure (Mayer, 1993)--for example, the steps of a biological process or an abstract rule applied to algebraic worked examples. To grasp this conceptual content, students often must compare the elements of a visual and consider how the elements relate to one another. Textbooks are an important source of educational visualizations. Our aim in this project was to explore how visual comparisons are presented and supported in STEM textbooks. We sampled two chapters each from the three most popular science and math textbooks in the U.S., identifying 1,087 total visuals (313 science, 774 math). We coded each visual for a) the presence of comparison, using text-based cues and symbols within the images (e.g., causal arrows), and b) the spatial alignment of corresponding visual elements--i.e., whether the placement of corresponding elements minimized conflict from competing matches

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(direct alignment) or if competing, intervening correspondences were present (impeded alignment) (Matlen, Gentner, & Franconeri, 2014). Altogether, 88% of math and 37% of science images involved comparison. However, a substantial proportion of the correspondences were impeded (24% science, 54% math). Thus, though visual comparisons are common in textbooks, support for mapping relevant correspondences is often lacking. We discuss implications for STEM learning and instruction.

2-C-42 The effects of gesture and action training on the retention of math equivalence

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Children benefit differently when math instruction includes gestures or actions (Novack et al., 2014). Here, we build on this work, asking: 1) whether instruction with gesture vs action differentially affects retention, 2) how gesture and action can be combined to promote learning and retention, 3) how children's prior knowledge impacts their response to different instruction types. 142 3rd-graders were taught the concept of math equivalence in 1 of 4 ways: same instruction throughout: action-only (AA), gesture-only (GG); or mixed instruction: action followed by gesture (AG), gesture followed by action (GA). Extending previous work, children show better retention of math equivalence when receiving GG vs AA instruction. To understand how gesture and action can be combined to promote learning, we examined differences in learning trajectories for children learning through AG vs GA instruction. Learning trajectories differed for children who received AG vs GA instruction, but this effect was driven by children with low prior knowledge. For children with low prior knowledge who learned via AG, understanding of math equivalence emerged over time, leading to higher retention scores for children who learned via AG vs GA. In contrast, children with higher prior knowledge showed similar learning trajectories regardless of how action and gesture were combined. This suggests that individual differences in prior knowledge should be considered when optimizing instruction.

2-C-43 The uptake of speech and gesture information in math instruction: Timing and modality matter

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Does the uptake of information provided in speech and gesture instruction differ: (1) depending on the timing of gesture in relation to language, (2) for deaf and hearing children? Seventy-nine hearing and 45 deaf children (ages 7-10) participated in a pretest-instruction-posttest paradigm designed to teach children mathematical equivalence (e.g., $7 + 3 = 5 + _$). In instructional videos, two different correct strategies for solving the problem were shown; one strategy was produced in English/ASL (equalizer that emphasizes that the two sides of the equation are equal in amount), while the other was produced in gesture (add-subtract that says the number on the right side of the equal sign has to be subtracted from the left side of the equation) or both strategies were produced in English/ASL. Gesture across instruction varied in timing with speech; occurring before, simultaneously with, or after speech. Although timing affected children's learning of how to solve problems; children benefited most when gesture occurred simultaneously with English/ASL instruction, timing did not affect children's emerging ability to explain new correct strategies. Deaf children tended to repeat in ASL the strategy produced in the observed instructional gesture (add-subtract) while hearing children tended to repeat the strategy produced in

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the observed instructional speech. Uptake of instructional input is influenced by multiple channels of information but differently for deaf and hearing children.

2-C-44 Motor based predictors of math achievement in kindergarten

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The link between fine motor skills and math achievement has repeatedly been established using the ECLS-K, a nationally representative project exploring child development across the early school years. After accounting for children's background variables and entering math skills, Son and Meisel's (2006) found that fine motor skills at the start of kindergarten had a positive effect on spring math achievement in 1st grade ($ES=.2$). Subsequent research supports these findings ($ES=.14$; Grissmer et al., 2010). In the present study we extend previous work with the ECLS-K by using Linear Mixed-Effects Modeling in R to measure the effects of teacher-reports of student's writing skills, parent-reports of early home activities, and psychomotor assessments of children's fine motor skills on student math achievement. After accounting for children's background variables (age at kindergarten entry, SES, hours in non-parental care, gender, and race) we not only replicated previous findings suggesting that fine motor skills relate to increased math achievement ($p<.001$), but also that writing skills ($p<.001$) and home activities ($p<.001$) relate to increased math achievement. Together, these findings suggest that writing and motor based activities are key skills implicated in the development of mathematics achievement. Broadly stated, the present research begins to address how motor development and numerical development are related and opens new avenues for potential assessment and intervention.

2-C-45 A left visual advantage in newborn infants when processing magnitudes

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In a series of two experiments, 32 neonate infants ($N=16$ for each Experiment; mean age = 46 hours) were first familiarized with an auditory stimulus (6 sounds, or 18 sounds). In Experiment 1, infants were then shown a test stimulus of an array of 24 items that was more or less numerous towards either side of the array (6 items, and 18 items), followed by a test stimulus that was mirrored along the vertical axis (see Fig 1). In Experiment 2, the test stimuli comprised a visual magnitude that matched the familiarized auditory magnitude, presented on the left, and then the right, side of the screen (counterbalanced for order). During testing, the familiarization sound continued playing. The mean looking times to the left-side target and right-side targets for Exp 1 = 38.3 vs. 27.9 ($p=.02$), and for Exp 2 = 44.6 vs. 35.4 ($p=.04$). Thus, in both experiments, infants looked longer to the visual test stimulus in which the familiarized magnitude was presented towards, or directly in, the left side of the screen. This suggests a prioritization of the left visual field when processing magnitudes, and supports a theory of an early mental number line that posits a left visual advantage as one of its innate driving factors.

2-C-46 Go figure: Effects of figural and numerical presentation on growing pattern generalization

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Patterning ability is an important, yet understudied predictor of math achievement (Rittle-Johnson, Zippert, & Boice, 2019). Using a between-subjects design, this study explored how figural and numerical presentation impacts 6th grade students' (38% females; 82% White) performance on multi-component growing pattern problems (adapted from Rivera & Becker, 2016, see Figure), and whether presentation of pattern problems influences later performance on far-transfer word problems when no figural or numerical pattern is provided. Figural and numerical presentation led to similar performance on near extension tasks, $t(59) < 1$. For far extension tasks, figural presentation led to better performance than numerical presentation, $t(59) = 4.43$, $p < .001$. These findings suggest that figural presentation may support student reasoning about patterns by making elements of the pattern more salient. However, there was no evidence that prior exposure to figural presentation improved performance on transfer problems. These findings align with previous visual model research (Sidney, Thompson, & Rivera, 2019), demonstrating students' difficulty spontaneously leveraging benefits of figures on transfer problems. Thus, additional instructional supports may be necessary to prompt children to produce drawings on transfer problems. We are analyzing strategy reports to assess relations between multiplicative reasoning (Steffe & Olive, 2009; Stephens, Blanton, Ellis, & Brizuela, 2017) and successful far transfer.

2-C-47 Strategies matter: Pre-instruction knowledge moderates the effect of instruction with gesture on math learning

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Input from instruction that includes co-speech gesture can improve math learning outcomes. A learner's knowledge state before instruction, reflected in problem-solving strategies, also affects learning. However, the effect of the interaction between children's existing knowledge and instruction with gesture has not been addressed. In this study, 79 children (Mage = 8.33 years) were taught to solve mathematical equivalence problems (e.g., $3+4+5 = __ +5$) either with or without gesture. Children's pre-instruction knowledge was coded based on their use of a single incorrect strategy or multiple incorrect strategies on a pretest. Results showed that instruction with gesture significantly enhanced learning compared to speech-only instruction, and children who used only one incorrect pretest strategy learned more than children who used multiple incorrect strategies. When measuring the effect of the interaction of strategy use and instructional input on learning, we found that single strategy users were significantly more likely to benefit from instruction with gesture, while multiple strategy users benefitted no more from instruction with gesture than speech-only instruction. Implications of the modulation of gesture's effect by individual differences in learners' pretest knowledge are discussed.

2-C-48 Reconciling "Symbolic Estrangement" and knowledge of symbolic magnitude

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Here we tested whether numerals are mapped to or 'estranged' from numerosity by examining the comparison of quantities denoted by 3-digit numbers. 30 3rd to 5th graders and 39 adults were asked to find the larger of two numbers, which were presented in dot-dot, dot-numeral, and numeral-numeral formats. Consistent with the 'estrangement' account, comparisons in the dot-numeral condition required more time than comparisons in other conditions (regardless of age). Consistent with the

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mapping account, solution times decreased ($p < .001$) and accuracy increased ($p < .001$) as ratios between two stimuli increased, including the mixed condition. We also observed a novel interaction between condition and ratio in adults. As the ratio between two numbers approached 1, symbolic comparison became faster than non-symbolic comparison, which was otherwise much faster at large ratios. These results suggest that symbolic numbers are useful when precise judgments are necessary, and the cause of 'estrangement' may come from differences in the precision that numerals permit rather than a failure of mapping symbols to their referents. In support of this idea, we found that the 'estrangement' effect was greatest when ratios were large enough for the precision of symbols to be distracting.

2-C-49 The rationale of the rational number: Children's organization of fractions and decimals

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Children's comprehension of rational numbers such as fractions and decimals is pivotal to mathematics achievement. The integrated theory of numerical development states children extend their number knowledge from whole to rational numbers. Organization between different rational numbers has not been investigated and may be especially challenging due to the difference in surface features of different number notations. We examined the semantic organization of rational numbers in children ($M = 106$ months, $SD = 44$ months; 57% female) using the spatial arrangement task (SpAM) and resulting Euclidean distances. The results indicate children used quantitative ($M = 3.74$, $SD = 2.17$) more often than notational organization ($M = 5.17$, $SD = 1.31$) and that use of quantitative organization was negatively correlated to age ($r = -.77$, $p = .04$). Overall, these results support the integrated theory and that younger children are more likely to be distracted by number notation.

2-C-50 Arithmetic knowledge from the spontaneous focus on relations

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Children's knowledge of arithmetic principles is a key aspect of early mathematics knowledge. Knowledge of arithmetic principles predicts how children approach solving arithmetic problems and the likelihood of their success. Understanding of arithmetic principles involves understanding how numbers in arithmetic equations relate to another. For example, the Relation to Operands principle is that for subtracting natural numbers ($A - B = C$), the difference (C) must be smaller than the minuend (A). Prior work has demonstrated that a brief intervention using symbolic numerals can affect children's knowledge of the Relation to Operands principle. In the current study we evaluated if individual differences in arithmetic principle knowledge can be predicted by the learners' spontaneous focus on relations (SFOR) with non-symbolic numbers. We also examine if feedback can increase their focus on non-symbolic relations and knowledge of the Relation to Operands principle. Our approach included a lab-based study with participants ($n = 64$) between 6 and 8 years old. Participants completed a series of SFOR and arithmetic principle knowledge assessments. After an initial assessment of both SFOR and arithmetic principle knowledge participants were given feedback. Participants were in one of two feedback conditions: number or relation. Participants in the number condition were instructed to attend to number, while participants in the relation condition were instructed to attend to relations. We evaluated the following hypotheses: Hypothesis 1: Children's SFOR will be significantly positively correlated with children's knowledge of the Relation to Operands principle. Prior work shows that

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knowledge of Relation to Operands is associated with attending to relative values in symbolic arithmetic equations. A high SFOR level should be positive correlated with attending to the relative values of numbers in arithmetic equations. Hypothesis 2: Training that directs children's focus to relations will significantly increase children's performance on the SFOR assessment. Hypothesis 3: Children's performance on the Relation to Operands principle assessment will significantly increase with SFOR training. If children's focus on relations can change with training, then an effect of this change may be a subsequent change in Relation to Operands knowledge. Results show that participants' SFOR score was not significantly related with their knowledge of the Relation to Operands principle, $r(64) = 0.07$. We did not find significant increase in children's SFOR assessment for either number or relation condition. Participants in the both Number and Relation condition did not show a significant increase in Arithmetic Principle knowledge score, $p = 0.69$, $p = 0.65$ respectively. We discuss several possibilities for the lack of correlation between SFOR and arithmetic principle knowledge, including difficulty in generalization across number contexts. Participants' focus with non-symbolic stimuli may not generalize to symbolic numbers. We also discuss how the results inform understanding of how children use non-symbolic number skills to make sense of early symbolic arithmetic.

2-C-51 Exploring effects of an early math intervention: The importance of parent-child interaction

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The frequency with which parents engage in math activities and conversations about math with their child is associated with the development of children's math skills. However, increasing math engagement at home is complicated and not always effective. Here, parents of 160 4-year-old children were randomized to one of five at-home training conditions: A math board game for parents and children to play together, a shape board game, a computerized parent-only math game, a computerized parent-only general trivia game, and a no-training control. Controlling for covariates (e.g., age, sex, vocabulary, child care, parent education) and baseline math skills, children of parents in the math board game condition outperformed those with parents in either parent-only training conditions on standardized math tests (math: $\beta = -.19$, $p = .01$; trivia: $\beta = -.16$, $p = .06$) but did not differ from those whose parents were in either the shape game condition ($\beta = .08$, $p = .29$) or the no-training condition ($\beta = -.01$, $p = .92$). Further, growth trajectories in math over four time points demonstrated children of parents in parent-only training conditions developed math skills at a slower rate than those in the board game conditions. Preliminary evidence suggests these negative effects of parent-only training are mediated by decreases in the frequency of parental engagement in math activities with their children, highlighting the need for increased sensitivity to parents' time limitations when designing interventions.

2-C-52 Inter-relatedness of pre-algebraic knowledge among middle school children

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Recent accounts in the development of mathematical knowledge argued that conceptual and procedural knowledge influence one another in an iterative fashion (Rittle-Johnson, 2017). There is also recent evidence that within conceptual knowledge, mastery of different topics (such as mathematical equivalence or fraction) is related to performance on other topics (like algebra; Booth & Newton, 2012; McNeil, Hornburg, Devlin, Carrazza, & McKeever, 2019). We are currently examining data from 1146

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middle school children using Bridge to Algebra (an intelligent tutoring system; Stamper et al., 2010). We explore whether students' accuracy in one concept is related to their accuracy for a different component. In a preliminary analysis we found that students' accuracy on fraction operation problems was correlated to their accuracy on solving one step equations ($r = .42$) and linear inequalities ($r = .44$). Solution of one step equations was also related to accuracy on linear inequalities ($r = .50$). We will explore whether this relationship is present when students start learning about these concepts or whether it emerges throughout the learning process. Our hope is that our results will enrich our understanding of the interconnectedness and co-develop of mathematical knowledge.

2-C-53 Acquiring the number concept: Sudden insight or gradual change?

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Acquisition of the natural number system appears protracted and stage-like (Carey, 2011; LeCorre & Carey, 2007; Sarnecka & Lee, 2009; Wynn, 1990, 1992). Children learn the cardinal meanings of number words one-at-a-time and in sequence, until they learn "four", when they seem to induce the cardinal principle and the successor principle and generalize their cardinal knowledge to all numbers (becoming a "CP-knower"). To determine whether this shift is sudden or gradual, we modified the GiveN task to look for gaps in children's cardinal knowledge. Our data suggest that children learn the first four number words in sequence. However, understanding "four" did not guarantee knowledge beyond "four". 63% of children had gaps, accurately giving larger numbers (e.g., eight, nine, and ten), while failing on smaller numbers (e.g., six and seven). Only 23% of children scored at the same "knower-level" at Time 1 and Time 2 (4 months later), suggesting acquisition may be less stage-like than previously thought. Other tasks showed that while "CP-knowers" had stronger implicit knowledge of the cardinal principle than "subset-knowers", they both lacked explicit knowledge of the principle. Likewise, "CP-knowers" successor knowledge outstripped that of "subset-knowers", but it was still far from complete. Our findings thus suggest that mature understanding of the natural numbers occurs gradually (Cheung, Rubenson, & Barner, 2017), rather than as a sudden conceptual shift (Carey, 2011).

2-C-54 Children estimate area using an 'Additive-Area Heuristic'

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How do we estimate quantity? Evidence suggests that infants as young as 6 months can discriminate visual displays by numerosity despite other correlated cues such as area, and that the acuity of this number sense predicts future mathematical achievement. Yet, relative to number estimation, area estimation remains relatively understudied. Moreover, recent work has shown that area perception in best predicted not by true, mathematical area (MA), but by the sum of a shape's dimensions ('additive area', or AA; Yousif & Keil, 2019, Psychological Science) -- raising the possibility that area estimations may play a larger role in quantity estimations than previously assumed. Here, we ask about the developmental origins of this 'Additive-Area Heuristic': do children, like adults, rely on AA for area estimation? 100 four to seven-year-old children (25 of each age) completed an area discrimination task and a number discrimination task (order counterbalanced). In the area discrimination task, each participant saw characters Nemo and Dory with different sets of colored dots (or "pictures of bubbles"; Nemo's in orange; Dory's in blue) presented on a touch-screen tablet. They were asked to indicate which group of dots took up the most space. Each participant completed 28 trials total. Critically, some of the

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trials varied in AA while others varied in MA. Consistent with adult work, we find that children at all ages rely on AA and not MA to make area discriminations -- suggesting that this tendency arises early in development. These results raise questions about how area and number have been controlled and equated in prior work. To address this issue, we conducted a number discrimination task where trials were either controlled for AA or MA (while the other dimension varied freely). Each participant completed 32 trials total. Overall, we found that number acuity across several different ratios was lower for AA-controlled trials as opposed to MA-controlled trials. This contrast suggests that (a) area may be influencing number judgments, but in a way that is qualitatively different from what has previously been observed, and (b) it is difficult to discern whether AA or MA controls best reflect true estimation acuity. This is especially relevant for work that has made claims about the relative acuity of area and number discrimination throughout development. Overall, we found that children, like adults, relied on AA and not MA to make area judgments. Further, we found that this reliance on AA directly impacts number discrimination tasks. Collectively, these results raise several concerns about studies of quantity estimation, while also suggesting that area may play a dominant role (relative to number) in visual quantity estimation -- even very early in development.

2-C-55 Gesture's impact on learning is modified by the emergence of the digital age

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Gestures in video-based instruction improves children's comprehension of abstract math concepts both early and late in development. However, past gesture research fails to consider how children's experiences with streaming technology interacts with video gestured instruction. Due to the emerging growth of technology use in the classroom and at home, we asked how children's experience with digital media influences the processing of gesture in video instruction. Chicago public and suburban elementary school children (N = 32; ages 7-9) completed a pretest, watched either a speech only or speech & gesture instructional video, then completed a posttest on problems reflecting the understanding of the equal sign (i.e., $3+4+5 = __+5$). Parents reported how many hours per week their children spent on video games, phone/computer, and TV. We examined the patterns of learning as a function of exposures to these different technologies (video games, computer, and TV). Children were split into low and high frequency of time (hours) spent using these 3 types of digital devices (based on a median split for each form of technology). Preliminary results showed that there are complex and intricate effects and interactions between each type of digital experience and receptivity to gestured video instruction. These different technologies either detract (video games), enhance (watching TV), or have no effect (computer/phone) on whether children benefit from video speech and gesture instruction.

D - Linguistic and conceptual development

2-D-56 Preschoolers statistical learning of multiple words for a referent

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Infants, children, and adults are adept at tracking the co-occurrences between words and their referents across ambiguous situations when each referent co-occurs with a single word. In the real world, however, young children may have to learn multiple words for the same meaning, such as when learning

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synonyms or two languages. In this pre-registered study (<https://osf.io/bd9gy>) we examined preschoolers' ability to track multiple labels vs. a single label for objects during statistical word-referent learning. We presented 4- to 7-year-old children ($N=61$, Mean age = 5.8, $SD=1.10$) with one of two statistical word-referent tasks manipulating the number of words co-occurring with each object. In the Single condition, each of 8 objects was paired with a single word. In the Double condition, each of 4 objects was paired with two words. Training was blocked such that, the first half of training presented 4 word-object pairings (First labels), while in the second half of training, either a new set of pairings was presented (Single condition) or the same objects were presented with second labels (Second labels; Double condition). Our results showed that both groups of preschoolers were equally successful at learning, suggesting that, in contrast to adults, young children's statistical word-referent learning is equally robust across single and multi-label conditions.

2-D-57 Children use presupposition to infer new word-referent mappings

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Discourse follows predictable patterns, backgrounding old information and foregrounding the new. The ability to track this structure is not only key to effective communication, but also a tool for extracting more information from language. For instance, the question "Is that a new spoon?" allows the listener to infer that the object is a spoon, regardless of the answer to the question--the identity of the object is presupposed. The similar question "Is that a spoon?" does not license this inference unless the answer to the question is "yes." We asked whether 3- to 6-year-old children are sensitive to this kind of presupposition in a novel noun learning task, and could use this skill to make new word-referent mappings. Children ($n = 56$) watched videos in which one person asked another if a toy on the table in front of them was "a blicket" or "a new blicket," and the other person responded "yes" or "no." Children then saw two toys--the one from the video and a novel competitor--and were asked to "Find the blicket." As predicted, we found an interaction between question type and speaker's response: "no" responses made children much more likely to select the novel competitor when the question was "Is that a blicket?," but not when the question was "Is that a new blicket?" Our results show that children are sensitive to the presupposition implied by description in questions, and can use this skill to learn new words.

2-D-58 Developmental differences in real-world concepts: More knowledge or different knowledge?

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Children have a remarkable ability to learn new concepts, yet we know very little about what they learn. Concept knowledge has been assessed in adults by having participants report the features that come to mind for a given concept (McRae et al., 2005). Using this approach, a key distinction has been made between two feature types: intrinsic (e.g., a hammer is made of metal), and extrinsic (e.g., a hammer is used to pound nails), with the latter thought to rely more on late-maturing associative learning mechanisms. We predicted that children's concepts would show greater developmental gains in extrinsic relative to intrinsic features. To test this hypothesis, we asked children and adolescents (ages 3-17 years) and adults to generate features for concrete concepts (e.g., duck, hammer, barn). We found

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an increase in the number of features generated per concept across development, consistent with the intuition that adults know more about the world than do children. However, we also found interesting developmental differences in the particular types of features generated. Specifically, there were larger developmental differences in extrinsic than intrinsic features, consistent with protracted maturation of associative learning shaping knowledge for real-world concepts. These results suggest fundamental differences in not just the amount, but the nature of knowledge across development. Further, these findings will serve as the basis for an open-access child concept knowledge database, so that developmental differences in feature knowledge can both inform studies using real-world stimuli and inform the creation of new mechanistic hypotheses linking brain maturation to knowledge

2-D-59 Not just for kids: Adults learn a counterintuitive scientific concept from a children's storybook intervention but self-explanation can hurt

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Natural selection is a counterintuitive concept, and many adults hold misconceptions about it. However, children can learn the fundamentals of natural selection from a custom storybook that provides a cohesive mechanistic explanation (Kelemen, 2019). We tested whether this storybook can help adults understand natural selection as well. On one hand, adults may be better able to process the story. On the other hand, their misconceptions may be more ingrained than children's, so interventions that help children may be insufficient for adults. In addition, we also explored whether undergraduates who self-explain natural selection prior to hearing an accurate storybook explanation show greater learning. We had a 2 (self-explanation: yes or no) x 2 (book: yes or no) between-subject design (n = 131). Posttest understanding was measured via forced-choice and open-ended questions. Participants who heard the storybook performed better at posttest than those who did not, $p < .001$ (see Fig 1). However, prior self-explanation hurt performance, $p < .01$. Content coding revealed that participants' pretest explanations were inaccurate. Thus, self-explanation likely activated misconceptions, inhibiting learning. In summary, the same storybook that helps children understand natural selection also helps adults. However, some teaching conditions are better than others: Despite benefits of self-explanation (Chi et al., 1994), self-explanation of a counterintuitive concept at pretest can hinder learning.

2-D-60 Concepts of universal quantification ("each" and "all") may support infant and adult understanding of collective and distributive actions

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The human mind can compress complex visual experiences via universal quantification, i.e., the concepts expressed with the words "All" and "Each". However, little is known about the mental computations underlying the detection and the tracking of collectively-exhaustive actions (e.g., "All of the wolves chased a sheep together") or distributively-exhaustive actions (e.g., "Each of the wolves chased a sheep by himself"), or their developmental origin. Here we tested adults and infants' representations of "All-" and "Each-" type movies in which chevron shapes were seen to "chase" moving balls. In Experiment 1, adults (N=36) spontaneously used the word "All" to describe movies depicting collectively-exhaustive chasing (e.g., 3 chevrons all pursued a single ball together), and "Each" for distributively-exhaustive chasing actions (3 chevrons each chased their own ball). Crucially, the use of "Each", but not of "All", significantly decreased when there were more than 3 chasing chevrons,

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suggesting that "Each" piggybacked on the representation of discrete individuals (within the capacity of working memory). In Experiment 2, we used visual habituation to test 10-month-olds ($N=36$). Infants habituated to the "All" movies successfully dishabituated to the "Each" movies and vice versa [Fig. 1]. These findings begin to suggest that the representations of collectively-exhaustive and distributively-exhaustive actions that connect with natural language quantifiers are in place early in life.

2-D-61 Do children benefit from comparing similar or varied events across time when learning verbs?

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When learning verbs, children need to go beyond contexts in which a verb is heard to be productive speakers. Children can compare events (e.g., Childers, 2011; Scott & Fisher, 2012), and this helps them extend verbs, but it is unclear whether they benefit from comparing similar or varied events. Also, in everyday life, events linked to a verb are separated in time but no study has asked how delays between events affect comparisons. In this study, 3½- ($n=31$) and 4½-year-olds ($n=36$) saw a set of 3 similar novel events, 3 varied events, or a single event while hearing a new verb (2½-year-olds in progress). Events were shown live and with familiar events as distractors. Three pairs of familiar (e.g., dog pulled in wagon) then novel events (e.g., sundae flipped with a spatula) were separated by 1 minute of reading. Children were asked to extend the verb using new objects in 2 test trials; the process was repeated for a second verb. Univariate ANOVA with Age (2:3s, 4s) and Condition (3:similar, varied, control) shows a main effect of Condition, $F(2,66) = 3.79, p < .03$. When seeing similar or varied events, 3½- and 4½-year-olds extended the new verbs, though only children seeing similar events differed from control (who were at chance). Thus, children benefited from comparisons, even when events were separated in time, and results favored similar events over more varied ones. These results will be discussed in reference to current theories, including Structural Alignment (e.g., Gentner, 1989).

2-D-62 Relationships between intuitive thought and learning about infectious disease in high school students

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Systematic relationships exist between intuitive thinking and misconceptions regarding scientific concepts in college-level biology students (Coley & Tanner, 2015). Applied biology curricula for public high school students increases scientific understanding and health literacy (Jacque et al., 2013). The current study investigated how intuitive thinking may impact student learning of formal biology concepts in the context of such curriculum. Researchers coded students' explanations of biological concepts on an exam administered both before and after this curriculum. Analyses examined the degree to which intuitive language on pre- and post-tests was associated with test performance. Results indicate that the use of intuitive language prior to implementation of the curriculum predicted better performance on the pre-test ($p=0.002$), but also predicted less improvement from pre-test to post-test ($p=0.003$), suggesting that reliance on intuitive thought may be helpful before scientific information is available, but that it interferes with the learning of science in the face of that alternative information.

2-D-63 Synchrony between hearing a label and holding the object: Evidence for an optimal object-label mapping experience

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Previous studies have shown that during dyadic naturalistic play infants are more likely to learn a novel object label produced by their caregiver if they are manipulating the labeled object at the same time. Those findings suggest that action on an object while learning the novel label may be beneficial. The present study seeks to further understand if the timing between hearing a label and manipulating the labeled object matters for object-label mapping in the absence of caregiver interaction. Thirty infants (18-22 months old) participated in an object-label mapping lab task with a learning phase immediately followed by a test phase. Three novel objects were randomly assigned to 3 different presentation conditions where we varied the timing of labeling relative to object manipulation: (1) labeling during look only (no manipulation), (2) manipulation followed labeling, and (3) concurrent labeling and manipulation. Frame-by-frame analyses revealed a shift in looking towards the target object, after the offset of the label, for the condition when the label was provided during manipulation ($p = .03$). There was no change in looking for the no manipulation condition or when infants were only allowed to manipulate the object after they heard the label ($ps > .93$). These findings suggest that hearing a novel label during object manipulation provides supports for word learning. Findings will be discussed within a dynamic systems framework.

2-D-64 Children can use probability to infer happiness without considering prior beliefs or close counterfactuals

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The probability of a good or bad outcome can influence people's happiness. For example, a girl will feel happier about receiving two yummy and two yucky gumballs if she initially had a higher chance of receiving a worse outcome (mostly yucky gumballs) as opposed to a better one (mostly yummy ones). Children understand this influence of probability on happiness (Doan et al., 2018; see Mellers et al., 1997; Shepperd & McNulty, 2002, for related work with adults). However, it is unclear how children make these inferences. Here, we contrast three potential accounts, and illustrate them using the example of the girl and the gumballs. First, children might infer the girl's happiness by asking whether the outcome she obtains exceeds or falls short of her prior beliefs (derived from the distribution of gumballs). This account is consistent with previous work showing that children consider beliefs when inferring emotions (e.g., Hadwin & Perner, 1991; MacLaren & Olson, 1993). Second, children might infer happiness by considering close counterfactuals, comparing the actual outcome with other outcomes that easily could have occurred (e.g., Teigen 1995, 1997). Third, children might consider whether the outcome is better or worse than the most probable outcome, without considering prior beliefs or close counterfactuals. We tested between these accounts by showing 4-6-year-olds ($N=180$) a story where a girl could either win a regular or special balloon from a set of 10 hidden balloons. In the Mostly Special condition, there were 8 special and 2 regular balloons; in the Mostly Regular condition, there were 8 regular and 2 special balloons. In both conditions, the girl won a regular balloon, but crucially, the distribution of balloons was revealed after her choice. As such, her prior beliefs could not differ across conditions. After the story, children judged how the girl felt about getting a regular balloon, using a 7-point scale ranging from extremely happy to extremely sad. Finally, to assess whether they considered close counterfactuals, children judged whether the girl could have easily gotten a special balloon. There

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was a significant age by condition interaction, $F(2,174)=8.51$, $p<.001$. Six-year-olds rated the girl as happier in the Mostly Regular condition than in the Mostly Special condition, $p<.001$. In contrast, 5-year-olds responded similarly across conditions, $p=.260$, and 4-year-olds gave higher ratings in the Mostly Special condition, $p=.025$ (see Figure 1). It is unlikely that children considered close counterfactuals, as responses to that question did not differ across conditions, $p=.413$. These findings reveal development in how children use probability to infer happiness. More importantly, they suggest that 6-year-olds may use probability to infer happiness, but without reasoning about prior beliefs and without considering close counterfactuals. These findings also advance knowledge of how children infer emotions. Developmental research has primarily focused on two ways that children infer emotions - relying on memorized scripts (e.g., Widen & Russell, 2010, 2011), and considering mental states (e.g., Harris et al., 1989). However, recent work has started to show that children also infer emotions by considering ownership, naïve physics, and probability (e.g., Doan et al., 2018; Ong et al., 2016; Pesowski & Friedman, 2015). This study adds to this growing literature and extends knowledge of how probability contributes to social cognition.

2-D-65 Using known words to learn more words: A distributional analysis of child vocabulary development

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Why do children learn some words before others? Studying variability in word learning at an item level as well as cross-sectionally may be informative of the processes that underlie word learning. We introduce a new predictor, ProKW_o (Proportion of Known Word Co-occurrence), which is designed to capture children's existing word knowledge when predicting future word learning. We calculate ProKW_o for each MCDI word (target word), at each month, from 16-30 months. To calculate the ProKW_o of a target word at a certain age, we first counted the number of other MCDI words with which that target word co-occurs in a 7 word window in the cumulative child-available speech addressed to a child of that age in the CHILDES corpus (MacWhinney, 2000). Then we multiplied each of those counts of co-occurring words by the proportion of children who say each of those co-occurring words (from WordBank; Frank et al., 2016) yielding a weighted co-occurrence count. ProKW_o is a ratio of the weighted co-occurrence counts and the unweighted co-occurrence counts. Compared to many common distributional predictors of lexical acquisition (e.g., frequency, contextual diversity) ProKW_o is a better predictor of the words kids say within and across age groups. Interestingly, unlike frequency, ProKW_o is equally predictive across lexical classes. We believe ProKW_o may capture a cognitively important dimension along which words may vary, with implications for the processes that underlie early language learning.

2-D-66 Cognitive predictors of reading, spelling, and arithmetic in Brazilian Portuguese-speaking children

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Introduction. The purpose of this study was to look at the predictors of reading, spelling, and math abilities in Brazilian Portuguese-speaking children. Math and reading abilities are highly correlated. Some authors (Hecht et al., 2001; De Smedt et al., 2010; Slot et al., 2016) have proposed that these correlations are due in part to shared variance contributed by components of phonological processing

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(PP), namely phonemic awareness (PA), rapid automatized naming (RAN), and verbal working memory (VWM). The main objective of this study was to evaluate the individual contributions of the PP components to word reading, spelling, and arithmetic achievement after controlling for verbal and nonverbal reasoning abilities. Method. 136 Brazilian Portuguese-speaking children (62 in Grade 4, 74 in Grade 5) participated. Mean chronological age was 10.13 years ($SD=.58$). Mean full scale IQ on the Brazilian edition of the Wechsler Intelligence Scale for Children-III (WISC-III; Wechsler, 2002) was 112.86 ($SD=14.44$). Participants completed a Brazilian standardized assessment of word reading accuracy, spelling accuracy, and arithmetic accuracy (Stein, 1994). A word-reading fluency test and an arithmetic fluency task also were administered. Verbal abilities were evaluated with the WISC-III Vocabulary and Similarities subtests. Nonverbal abilities were evaluated with the WISC-III Block Design and Object Assembly subtests. A working memory-sentences task was used to measure VWM. A phoneme deletion task was used to assess PA, and RAN was measured using numbers and letters. Raw scores were used for all measures. Results. Performance on the literacy measures was moderately to strongly correlated with performance on the arithmetic measures (r s ranging from .43 to .57, p s<.01). All correlations between performance on the achievement variables and the predictor variables (Grade, verbal ability, nonverbal ability, VWM, PA, and RAN) were significant (r s ranging from .25 to .61, p s<.01). Five multiple regression analyses were performed with word reading, word-reading fluency, spelling, arithmetic, and arithmetic fluency as the dependent variables. For word reading ($R^2=.51$), verbal ability ($p=.029$), nonverbal ability ($p=.007$), PA ($p<.001$), and RAN ($p=.011$) made significant independent contributions. For word-reading fluency ($R^2=.56$), Grade ($p<.001$), PA ($p=.001$), and RAN ($p<.001$) made significant independent contributions. For spelling ($R^2=.48$), PA ($p<.001$) and RAN ($p=.001$) made significant independent contributions. For arithmetic ($R^2=.46$), Grade ($p<.001$), verbal ability ($p=.026$), nonverbal ability ($p=.021$), and VWM ($p=.005$) made significant independent contributions. For arithmetic fluency ($R^2=.54$), nonverbal ability ($p<.001$), VWM ($p=.001$), and RAN ($p<.001$) made significant independent contributions. Discussion. As expected significant correlations were found between cognitive factors and academic achievement measures. This result is consistent with the generalist genes hypothesis proposed by Plomin and Kovas (2005) that there is a substantial genetic correlation among cognitive abilities. The finding that PA and RAN significantly predicted reading and spelling in Brazilian Portuguese is consistent with findings for other alphabetic languages. The importance of VWM for both arithmetic measures and the relevance of RAN for arithmetic fluency is consistent with the relevance of some aspects of PP for math. Theoretical and practical implications will be discussed.

2-D-67 Five-year-olds' sensitivity to speakers' visual perspective and knowledge about object identity during real-time language processing

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We examined 5-year-olds' attention to different types of knowledge representations in real-time language comprehension. In the shared-knowledge condition, the child and the speaker knew the identity of a deceptive object (e.g., a candle that looked like an apple). In the privileged-identity condition, only the child knew the identity of the deceptive object. In the privileged-existence condition, the child had visual access to objects the speaker could not see. Children were presented with a target object, a competitor (a deceptive object), and two unrelated objects. We examined patterns of fixations as the speaker instructed the child to find a particular object. Results indicate that children in the privileged-identity condition were more likely to fixate the deceptive object than those in the privileged-

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existence condition. Thus, children's knowledge about the identity of the deceptive object influenced their language processing, even though the speaker was unaware of the object's true identity.

2-D-68 Robust semi-supervised learning in 2-year-olds: Learning in challenging conditions

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Research across many different laboratories has revealed that the labels children hear play a powerful role in the object categories they form. In children's daily life, however, category exemplars often go unlabeled. How, then, can we reconcile the power of labels in infant categorization with their relative scarcity in infant experience? Recent evidence reveals that 2-year-olds engage successfully in semi-supervised learning: integrating a few labeled exemplars with subsequently presented unlabeled exemplars to learn a novel category. Here, we test the robustness of 2-year-olds' semi-supervised learning by imposing additional constraints that more closely resemble the learning conditions they typically encounter. First, we present 2-year-olds with not only relevant but also irrelevant exemplars in a familiarization paradigm. Two-year-olds ($n=24$) in this condition showed a preference for the novel category exemplar at test, $p<.01$, suggesting they learned the target category despite the presence of irrelevant exemplars. Second, we present another group of 2-year-olds ($n=24$) with only a single labeled category exemplar, effectively denying children the opportunity to compare multiple labeled exemplars, as in prior work. In this condition, learning was marginal, $p<.1$, and their looking patterns over time diverged significantly from a semi-supervised condition that included two labeled exemplars, $p<.05$. These results demonstrate the robustness of 2-year-old children's learning in sparsely labeled environments and highlight the advantages of receiving multiple labeled exemplars.

2-D-69 Children's explanations of natural events

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Children tend to describe animals, plants, and natural objects as existing for a purpose (Keleman, 1999). This study examined 6- and 7-year-old children's explanations of natural events, such as thunderstorms and sunsets, to determine whether they would choose such purpose-based, or teleological, explanations over physical explanations for these events. Children were asked to choose an explanation for why natural events occurred over 12 trials, which included negatively, positively, and neutrally valenced teleological explanations. Data collection is ongoing, but preliminary results ($n = 16$) show that while the overall rate of teleological explanations was low, participants' endorsement varied according to the valence of the explanation. Children were more likely to endorse teleological explanations for natural events when the explanation was positive in tone than when the explanation was negative or neutral, $p < .05$. Children only chose negatively valenced teleological explanations on 2% of the trials. Also, 7-year-olds were less likely than 6-year-olds to choose teleological explanations regardless of the valence of the explanation, $p < .05$.

2-D-70 The role of inhibitory control in syntactic ambiguity processing

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Children sometimes have trouble resolving syntactically ambiguous (SA) sentences. For example, the sentence "Put the frog on the napkin in the box" can be challenging because the phrase "on the napkin" could refer to the frog or to the box (Trueswell et al., 1999). Successful resolution of SA sentences depends on several factors, including inhibition of the initial interpretation for re-analysis. Thus, this study explores the role of inhibitory control (IC) in resolving SA across two modalities. Five-to 8-year-olds completed three IC tasks (Day Night Stroop, Flanker, Go/No Go) with performance across tasks distinguishing between "high" and "low" IC participants. Children also completed a computer "drag and drop" game in which they responded to audio and text presentations of SA sentences. Preliminary results ($N = 21$) suggest that SA is challenging for children overall, but children with high IC outperform their low IC peers ($p = .041$). Further, results indicate that this performance difference is especially pronounced in text presentations of SA ($p < .001$). Implications of the effect of presentation modality on SA performance, specifically for educational practice, are discussed.

2-D-71 Do 6-month-olds consider the role of mutual engagement in 3rd party communication?

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Speech is often used to communicate, but simply observing two people speaking may not indicate that successful communication has occurred. If a waiter at a restaurant approaches someone and says, "can I take your order?", it would be surprising (and rude!) for a customer at another table to yell out, "I'll have the fish!". This is because--although the response fits the question--answering only becomes appropriate when that customer is the target of that communication. Paying attention to the social context surrounding speech influences how we evaluate interactions as communicative--but how does this ability develop? By six months, infants show some understanding of how speech is used in social interactions. They understand that speech is typically directed toward other people (Legerstee et al., 2000) and that it can transfer information from one person to another (Vouloumanos et al., 2014). But do infants expect speech alone to result in communicative success or are they also considering the broader social context of the interaction? We investigated whether 6-month-olds consider mutual engagement between conversational partners to be an important cue that communication is occurring. We tested forty-eight, 5- to 6-month-olds using a third-party, live-action play. Infants were first familiarized to a Speaker, alone on stage, who looked at two novel objects and always chose a target object to play with. Next, they watched another actor (the Listener), alone in a different part of the stage, look at and play with both objects. In a test scene, the Speaker, who could no longer reach the objects, turned to the Listener and uttered a novel word "koba." The Listener either presented the target object or the non-target object. During speech, the actors were either facing each other (mutually engaged), the Speaker was facing opposite the Listener (speaker-disengaged), or the Listener was facing opposite the Speaker (listener-disengaged). Looking times were coded online by two observers. Infants looked longer when the Listener presented the non-target object ($M = 30.63$) compared to the target object ($M = 13.38$) only when the actors were mutually engaged ($t(14) = 3.03$, $p = .01$). There were no looking time differences between target and non-target outcomes in either speaker-disengaged ($t(14) = .58$, $p = ns$) or listener-disengaged ($t(14) = .450$, $p = ns$) conditions. We are also examining infants' attention to the test event across conditions to shed light on the mechanisms that may underlie infants' online conversational tracking (as in Koenig & Echols, 2003; Thorgrímsson et al., 2015; Yamashiro & Vouloumanos, 2018). Results from these analyses will be discussed. Our study suggests that pre-verbal

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infants' early understanding of the communicative function of speech is tied to a rich social interaction. Knowing which contextual factors infants are attuned to in social interactions can provide insight into our communicative development.

2-D-72 The association between early bilingualism and selection into later foreign language learning

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Bilingualism has been associated with positive outcomes, including an advantage in executive function, which could lead to better academic achievement. Early exposure to multiple languages shapes children's experiences and language background as well as influences later functioning. Prior research in several developed countries indicates that students who speak a minority language at home experience unique benefit when learning an additional third language (L3) in school. In the context of the United States, where foreign language learning is not mandatory, it is challenging to directly examine this relationship. Not all students decide to take a foreign language course, and it is assumed that those who choose to enroll in these courses differ from those who do not in several ways. Student characteristics may influence their motivation to learn a foreign language. However, no study has examined the relationship between student language status (monolingual, dual language learner [DLL], and bilingual) and later foreign language learning. The present study, using longitudinal data from the Miami School Readiness Project (MSRP), explored this association. 30,508 students (60% Latino, 33% Black/African American, 7% White/Asian/other; 64% free/reduced lunch) who attended public school pre-K or received subsidies for center-based or family childcare in the community were assessed for school readiness at age four and prospectively followed through high school. School record data indicated DLL status in kindergarten, early English proficiency, and foreign language course taking in middle and high school. We examined three groups - non-DLLs who spoke English at home ("monolingual"); "dual language learners (DLL)" - students whose home language was not English and who were not proficient in English by the end of kindergarten; and "bilinguals" - DLLs who were proficient in English by kindergarten. We ran multivariate logistic regressions with foreign language course enrollment (Spanish and non-Spanish languages) in middle or high school as the outcome, with students' gender, reduced/free lunch status, and race/ethnicity as covariates. Results showed that after taking into account of the covariates, the early bilingual students had the highest odds of taking a foreign language course later, followed by dual language learners and monolinguals. Additionally, the odds of taking a foreign language course varied by the type of language chosen. Monolingual and bilingual students were more likely to take Spanish classes compared to DLL students. Early bilingual students were more likely to take non-Spanish foreign language courses (clearly an L3) compared to DLLs and monolinguals. Finally, black students, students in poverty, and male students had fewer odds of enrolling in foreign language courses compared to their respective counterparts. Implications and future directions are discussed pertaining to bilingualism and foreign language learning research.

2-D-73 Is a picture worth 1000 words? Neural engagement during fast mapping vs word learning from context

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Many early words are learned by fast mapping or mapping novel words to observable objects or actions in the surroundings. Older children and adults learn new words by inferring their meaning from the surrounding linguistic context. Word learning from context, a more difficult task, is thought to lead to a richer semantic representation. In this study, we used time frequency analysis of EEG to identify differences in neural oscillations to words that are learned via Fast Mapping vs Linguistic Context. Eight children ages 12-16 completed 2 word learning tasks while their EEG was recorded. One task provided linguistic context, and another provided picture referents to aid word learning. Target novel words were presented thrice. We used a Monte-Carlo cluster correction permutation analysis to compare neural engagement in response to the novel word for the two tasks across three presentations in a 2 (task) x 3 (presentation) within subject ANOVA. Children displayed significantly higher frontal theta (4-8 Hz) between 400-600 ms after seeing the novel word, during word learning from context compared to Fast Mapping. This was especially pronounced in the third presentation of the word. No other frequencies exhibited significant differences. Theta power is associated with semantic integration and retrieval in language comprehension tasks. Our findings suggest that higher levels of semantic integration are engaged when learning words from linguistic context vs fast mapping.

2-D-74 Contrast in word learning: To not or not? The use of labels versus negation

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Labeling and contrasting objects are useful for word learning. This study sought to determine if negation (i.e., "wug and not a wug") helps to distinguish categories from one another better than different labels (i.e., "wug and modi") for shape categories. Thirty-two three-year-old children participated. All children saw one distractor object, three learning objects, and four test objects. The three learning objects differed on shape. In the label condition these objects were labeled with novel words (i.e., "wug", "dac", "modi"). The negation condition objects were labeled with a novel word for the target object (i.e., "wug"), and with the negation of that word for the other two (i.e., "not wug"). The test contained four objects: one new target, the distractor object, a novel object, and a false match object. The results inform the literature on word learning with contrast as to what features of contrast are important for young word learners.

2-D-75 Connections between language brokering frequency and academic motivation and learning strategies in college students

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Previous research studying language brokers (i.e., children/adolescents who translate for family members) has indicated a positive correlation between frequent language brokering and gains in cognitive development. However, there is evidence documenting elevated levels of anxiety in brokers, which may undermine cognitive developments. The purpose of this study was to (1) examine how the frequency of language brokering in participants' (N=644) childhood and anxiety levels would independently predict academic motivation and learning strategies in college, and (2) examine how anxiety levels would interact with frequency of brokering. Participants responded to the Penn State Worry Questionnaire (PSWQ) and the Motivated Strategies for Learning Questionnaire (MSLQ). When examining motivation and attitudes about classes, higher frequency of brokering and higher anxiety were independently predictive of higher motivation, $F(2,545) = 5.91$, $p = .003$, $R^2 = .018$. However, the

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interaction between these terms did not create a significant change in R^2 when entered into the model, $p = .688$. When examining learning strategies and study skills, only higher frequency of brokering was predictive of greater learning strategies, $\beta = .095$, $p = .030$. Rooted in Bronfenbrenner's Bioecological Systems Theory, these findings help to more directly understand the context of the language broker in emerging adulthood and the impact on cognitive outcomes during this important transition into adulthood.

2-D-76 Day-by-day vocabulary learning through reading aloud at home

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There is a robust body of evidence in the field of children's language and early literacy development that demonstrates that reading aloud with young children can grow, bolster and diversify vocabulary. Our work takes a closer look at the potential benefits of both specific book-level features, and the subtle strategy choices that adult readers employ as they engage children with the novel vocabulary they encounter in stories read aloud. In a series of experimental studies we have found that linguistic features such as use of rhyme and novel word placement within storybook texts can help children retain new words. We have also found that when adults engage in simple strategies such as pausing before new words to invite prediction or orient a child's attention, this too can boost children's new word retention. The current study builds directly upon this prior research on the connection between reading aloud and vocabulary building in 3- to 4-year-olds. In this most recent work, we are investigating the combined effects of rhyme and parents' spontaneous interaction strategies on new word retention in a more natural setting with books that clearly and deliberately present novel words. Parent-child pairs are provided with either a rhymed or unrhymed version of the same story, along with an audio recorder, and are instructed to record reading the book aloud with their child daily for five consecutive days. Both versions of the book contain novel names and illustrations of the same eight imaginary monsters. After completing the readings, children are tested on novel word (monster name) retention with both an identification task and a production task. Audio recordings of each of the parents' five progressive read-alouds are transcribed and coded for conversational elements including extra-textual word count, number of conversational turns, intentional pauses, and both parents' and children's rates of commenting on the novel names, in order to test not only whether children retain the novel words differently based on the rhyme/nonrhyme manipulation, but also how parents' strategies around introducing new words differ for rhymed vs. unrhymed books, and how these patterns change over the course of multiple read-alouds. Early findings from this study indicate that both parents and children respond differently over time to rhymed vs. unrhymed books, and that children whose readings involve more consistent extra-textual interactions retain and recall more novel words. Preliminary results also indicate reading style varies greatly across parent-child pairs but less so within individual pairs over time, and that the effects of reading strategies have a more direct impact on children's ability to recall and produce the novel words compared to their simple retention and identification of the words. Also of note is that children in this study are overall more successful at remembering the novel words than in previous studies using the same monster books, likely because here in this study they have the opportunity to participate in more natural "every day" interactions through repeated readings at home.

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2-D-78 Combatting the summer reading slide through a book distribution program

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During their summer break from school, children are at risk of losing some of their learning progress from the school year. The current project evaluates an early-literacy program aimed to combat this "summer reading slide" by providing books to students to read during the break. Our first cohort (2017) included 412 students who completed reading assessments in the Spring of second-grade and the Fall of third-grade. Our second cohort (2018) included 710 first-graders and 629 second-graders. Over 80% qualified for free/reduced lunch. Compared to matched peers, children in schools that adopted our book distribution program had increased reading scores on standardized tests, with the impact of this intervention most pronounced for students already falling behind. This finding held true for both years of the program, suggesting a more cost-effective way of supporting children across the summer months than expensive camps with extensive staff, time, and transportation requirements.

2-D-79 Perceptual and linguistic contrast promote indirect word learning

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Young children can acquire new vocabulary words--even property terms--through indirect learning (Carey & Bartlett, 1978). Shao and Gentner (2016) found effects of perceptual alignability in this learning: 3- and 4-year-olds learned a new color term (as assessed by a later test) when given highly alignable pairs of objects, but not when given less alignable pairs. The current study explores how linguistic cues, in addition to perceptual cues, influence indirect word learning. As in Shao & Gentner (2016), 4-year-olds were given an indirect learning situation, with high- vs. low-alignable pairs. In addition, we varied the kind of information in the linguistic cues: (1) full semantic and syntactic contrast ("Can you point to the chromium one--the chromium one, not the blue one"); (2) semantic contrast only ("I don't like the blue one; can you point to the one that is chromium"); (3) syntactic contrast only ("Can you point to the chromium one--the chromium one, not that one (with gesture)"). With low-alignable perceptual cues, children failed to learn the novel color word regardless of the linguistic cues. With high-alignable perceptual cues, children showed better learning in the full contrast condition than when given only semantic contrast or only syntactic contrast. We conclude that both perceptual alignment and linguistic contrast are important in facilitating young children's indirect word learning.

2-D-80 The effect of number of familiar object foils on novel name mapping: Is there a metacognitive advantage?

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From an early age, children show a tendency to map a novel name onto a novel rather than a familiar object (Halberda, 2003). During early childhood, this mapping tendency becomes increasingly robust (Lewis & Frank, 2015). Slocum and Merriman (2019) found that increasing the number of familiar object foils had a greater negative impact on the mapping tendency in younger than in older preschoolers. Moreover, individual differences in metacognitive awareness accounted for this age difference. We tested whether these findings would replicate. We also examined how the number of familiar object foils affected children's scanning of the objects. Forty preschoolers completed novel name mapping

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problems that involved a novel object and 2-to-5 familiar objects while their gaze patterns were recorded by an eye tracker. As in Slocum and Merriman (2019), increasing the number of familiar object foils had a greater negative impact on speed of correct responses in low than in high metacognitive children. This difference was linked to differences in how the number of foils affected the efficiency of object scanning processes.

2-D-81 Preschoolers inflexibly attend to lexical over paralinguistic cues in affective judgments of speech regardless of their level of executive function and theory of mind

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We investigated preschoolers' ability to use paralinguistic cues in judging emotion from speech, and whether executive function (EF) and theory of mind (ToM) would relate to this ability. Thirty-seven 3- to 5-year-olds judged whether a speaker was happy or angry in (1) utterances with lexical and paralinguistic cues that were either consistent or inconsistent (e.g. "I'm having fun" spoken happily or angrily), in which adults based their affective judgments on paralinguistic cues and (2) low-pass filtered utterances in which prosodic variation, but not lexical content, was preserved. Children additionally completed measures of vocabulary, EF, and ToM. Children performed near ceiling when judging emotion from utterances with consistent lexical and paralinguistic cues, and significantly above chance when judging emotion from low-pass filtered utterances. However, children performed significantly below chance in judging emotion according to paralinguistic cues in utterances with inconsistent lexical cues, and this performance was not significantly predicted by their age, vocabulary, EF, or ToM. Our results are consistent with previous research suggesting that preschoolers show a robust bias in attending to lexical over paralinguistic cues in affective judgments of speech (Friend, 2000; Morton & Trehub, 2001), and also suggest that EF and ToM, at least at the preschool level, may not contribute to the ability to attend to paralinguistic cues in such affective judgments.

2-D-82 Pondering preschoolers: Developmental differences in information seeking about new words

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Research has clarified that preschoolers use information adults provide to learn new words. It is less clear whether they also solicit information about unknown words. To investigate this, we asked 3- and 5-year-olds to perform 18 actions that involved either one of nine known (e.g., lift, touch, move) or unknown (e.g., transpose, invert, mobilize) verbs. Nonverbal (looks toward the speaker) and verbal (questions about words) information-seeking behaviors were predicted to be more frequent for unknown than known words. This prediction was confirmed: both age groups looked toward the speaker more for unknown words ($M=7.19$, $SD=3.37$) than known words ($M=4.81$, $SD=2.45$), $F(1,34)=24.57$, $p<.001$. Older children looked at the speaker more overall ($M=6.89$, $SD=3.24$) than younger children ($M=5.00$, $SD=2.79$), $F(1, 34)=5.23$, $p=.02$. Both groups asked more questions about unknown words ($M=3.31$, $SD=3.35$) than unfamiliar words ($M=0.17$, $SD=0.45$), $F(1, 34)=49.23$, $p<.001$. However, an interaction revealed the effect was larger for the older children, $F(1, 34)=19.34$, $p=.001$. These findings suggest that preschoolers have nonverbal and verbal tools for soliciting information about words.

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2-D-83 Daxing with a Dax: The relationship between artifact-function polysemy and the design stance

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How do we conceptualize artifacts? When asked what an artifact is for, adults exhibit a design stance, and appeal to the original, designed function of the artifact, as opposed to how the artifact is currently being used (German & Johnson, 2002). Also reflecting the importance of function to artifact concepts, many languages employ the same words to label artifacts (hammer, shovel) and the functions of those artifacts (She hammered the nail). Across three studies, we ask how artifact-function polysemy relates to how artifacts are conceptualized by adults and children. When an artifact's name (e.g., dax) is used to refer to a function (daxing), do speakers assume that this is the original, designed function of the artifact? And can providing the same label for an artifact and a function of that artifact shape intuitions about what that artifact is for (e.g., daxes must be for daxing)? Study 1 (98 4-year-olds, 36 adults) replicated previous findings that, in contrast to adults, children do not exhibit a robust design stance toward artifacts (Defeyter et al., 2009). Participants learned that a novel artifact was originally created for one function (pulling yarn), but now, everyone uses it for another function (prevalent condition) or one person does so (idiosyncratic condition). While adults reliably judged that that the artifact was "really for" its original function in both conditions, 4-year-olds only reliably made this judgment in the idiosyncratic condition, failing to exhibit a design stance when the later use of the object was more prevalent. Study 2 moved from measuring intuitions about an artifact's function to assessing interpretations of artifact-function polysemy. In the polysemy condition (82 4-year-olds; 36 adults), participants were introduced to a novel artifact (e.g., a dax) and were asked whether the verb formed from the artifact name (daxing) corresponded to the artifact's original or later function. Participants in the contrast condition (93 4-year-olds; 36 adults) were instead asked to select the function corresponding to a contrasting verb (e.g., zotting). Both adults and children preferred to extend the polysemous verb (daxing) to the original function and the contrasting verb (zotting) to the later function, though this effect was stronger in adults, especially when the later function was idiosyncratic. Taken together with Study 1, these results suggest that although preschoolers do not exhibit a strong design stance, they expect artifact-function polysemy to correspond to an object's original, designed function. Study 3 (32 4-year-olds; 22 adults, data collection ongoing) asked whether polysemy shapes judgments about artifact function. We taught participants names for new artifacts (e.g., dax) and manipulated whether the polysemous verb formed from the artifact name (daxing) was used to label the artifact's original or later function, and then asked what the artifact was "really for." Polysemy did not affect adults' judgments: they were equally likely to judge that the artifact was for the original function regardless of which function received the polysemous label. Trending evidence, however, suggests that children are more likely to select the original function when it receives the polysemous label, suggesting that polysemy may help children adopt a design stance toward artifacts. Taken together, these studies provide new insight into the relationship between artifact concepts and words over development.

[E – Psychological and moral reasoning](#)

2-E-84 'Tell me what you want, what you really really want': Constraints that guide early helping decisions

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Providing effective help to another person can require children to consider multiple pieces of information, including what the recipient's goals are (Warneken & Tomasello, 2006) and information the recipient does and does not know about (Liszkowski et al., 2008). We investigated how toddlers decide to help another person when information about common ground and recipient goals are in conflict. Forty 2-year-olds were shown an opaque container of blocks (hidden blocks) and a transparent container of blocks (visible blocks). Participants were shown a colourful tube and told that they could make music by putting blocks inside the tube. For half of the participants, both hidden and visible blocks worked but for the other half, only the hidden blocks worked. Then, a naïve confederate entered the room and asked toddlers for help playing music. When both blocks were functional, participants chose the block in visual common ground ($n=19$) significantly more often than the hidden block ($n=1$; $p<.001$). However, when only the hidden block was functional, toddlers favoured function and gave the confederate the functional but hidden block ($n=15$) significantly more often than the visible but not functional block ($n=5$; $p<.05$). These findings demonstrate that 2-year-olds are able to use visual common ground to guide their helping decisions, but can also consider the affordances of the available objects for achieving a goal and will override visual common ground in favour of goal fulfillment.

2-E-85 Children's preferences between equal and equitable tax divisions

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Taxes involve the mandatory giving of resources to a communal collection system (Kirchler, 1997). American adults have enormously conflicting opinions about taxes. Some argue that advantaged individuals should be taxed more; others argue that taxes should be equal, regardless of wealth. Every year, Americans report anger, anxiety and paranoia about tax season and millions even cheat on their taxes (Rosenberg, 1996). Though taxes are among the most controversial political topics in America, curiously little is known about how such judgments develop. We investigated 4- to 8-year-olds' perceptions about the fairness of resources levied by teacher for a communal purpose (62 female, Mean = 77.49 months, $N = 120$). Children observed a narrative about students with varying amounts (range 2 to 5 stickers) and a teacher stating that students must bring stickers for a shared project. We tested children's preferences between: (a) the teacher taking more stickers from an advantaged student (i.e., 2 stickers from a student with 3 stickers) versus a disadvantaged student (i.e., 1 sticker from a student with 2 stickers) compared to (b) the teacher taking the same amount from both (i.e., 1 sticker from each). We also asked a control question about numeracy comprehension. Preliminary results show an age effect of tax preference; older children prefer the teacher to tax the advantaged student more ($r(118) = .314$, $p = .001$). To our knowledge, this is the first study to explore children's developing preferences for tax divisions. Our results demonstrate that younger children prefer a numerically equal tax division, but older children prefer an equitable tax division for a communal purpose.

2-E-86 Moral reasoning and moral behavior: Intersections of reasoning with aggressive forms and functions in early childhood

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Considerable research has demonstrated children's capacities for complex socio-moral reasoning across domains; similarly, research on children's aggressive behaviors shows robust and consistent findings regarding developmental patterns and socio-emotional antecedents. For instance, proactive aggression

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has been shown to correspond with difficulty in distinguishing between moral and conventional issues (Jambon & Smetana, 2018), and considerable research demonstrates that young children tend to focus more on gender-proscriptive and -prescriptive behaviors in their explanations for reasoning about moral events, especially compared with older children (Baker, Tisak, & Tisak, 2016; Killen & Stangor, 2001). However, with a few exceptions, little research has considered children's socio-moral reasoning and aggressive subtypes in concert with consideration of differences by gender. The aim of the current study was to examine moral reasoning strategies and specific aggressive behaviors in early childhood as they relate to gender differences. 130 preschool-aged children (Mage = 56.05 months, SD = 9.21, [range: 37-78 months], 62 girls) completed the Accidental Transgressor Task (Killen et al., 2011), a story-interview task in which a character causes unintended harm to another child's property. Children are asked a series of follow up questions regarding the character's intentions, emotions, and mental state. Children's primary classroom teacher completed the Preschool Proactive and Reactive Aggression-Teacher Report questionnaire (PPRA-TR; Ostrov & Crick, 2007) for each child, which provides measures of four specific types of aggression. A series of ANOVA revealed several groups mean differences. For the physical reactive aggression, the model explained a large portion of variance in aggression scores ($\eta^2p = .42$) and we found Age x Justification type interaction [$F(6, 106) = 1.99, p < .05, \eta^2p = .20$]: older children using a moral domain strategy received higher scores of aggression [$M = 1.78, SE = 0.21$] than did younger children [$M = 1.12, SE = 0.19$]. A similar pattern was found for children who used provided justifications related to conventional domain: older children received significantly higher aggression scores [$M = 1.75, SE = 0.22$] than did younger children [$M = 0.02, SE = 0.22$]. For the relational reactive aggression, the model explained a large portion of variance in aggression scores ($\eta^2p = .39$) and we found Age x Justification type interaction [$F(6, 106) = 1.97, p = .05, \eta^2p = .20$]: older children who reasoned about moral issues received higher scores of aggression than did younger children. In contrast, children reasoning in a conventional domain strategy showed the opposite pattern: older children received lower scores of reactive relational aggression [$M = 0.44, SE = 0.21$] than did younger children [$M = 1.08, SE = 0.29$]. We also found Age x Gender interaction [$F(2, 106) = 2.416, \eta^2p = .09$]: older boys received higher scores of aggression ($M = 0.89, 95\% \text{ CI } [0.51 - 1.15]$), compared with younger boys ($M = 0.41, 95\% \text{ CI } [0.05 - 0.75]$), whereas aggression scores for girls did not vary as a function of age. Overall, these findings support and expand on previous research on children's reasoning and aggressive strategies. Limitations and future directions will be discussed.

2-E-87 Infant abilities to distinguish between moral and conventional transgressions

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Toddlers can distinguish moral from conventional transgressions by 3 years of age (Smetana, 1981). Potential precursors to this ability include 6-month-olds' ability to differentiate helpers from hinderers (Hamlin et al., 2007). Here we examined the moral-conventional distinction in infancy. Experiment 1 established that infants distinguish moral transgressors from a neutral character. Twelve-month-olds were first familiarized to a moral transgression (i.e., an individual refusing to join a group and also pushing members of the group) and a conventional transgression (i.e., an individual refusing to join the group). At test, infants looked reliably longer when one member of the group chose to affiliate with the moral transgressor than with another group member, ($t(34) = 1.84, p = 0.03$, one-tailed). Experiment 2 (ongoing) examines infants' responses when the group member affiliates with the moral vs. the

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conventional transgressor. Cross-experiment comparisons will show whether infants distinguish between the moral and conventional transgressions.

2-E-88 What makes comforting behavior difficult for young children? Examining the problem-solving and social engagement requirements of prosocial behavior

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Acting on behalf of another requires recognition of the person's need and the possible interventions to meet that need, as well as a motivation to act. Early in development, though, children do not appear to respond to all types of needs with the same readiness. Responding to an instrumental need (e.g., helping by picking up dropped objects), for example, is often seen earlier than responding to an emotional need (e.g., comforting an injured other). Here, in a two-by-two design, we examine two possible reasons for this difference: the relative cognitive opacity of comforting interventions and the social engagement requirements they can entail. Forty-two 4-year-olds participated in two helping and two comforting tasks (Figure 1). For half of the tasks, prosocial intervention required interacting closely with the experimenter (e.g., helping by removing an unwanted sticker from her jacket). Nearly all children helped, regardless of whether low or high engagement was required (Low = 42/42 (100%), High = 40/42 (95.2%)). Comforting was less frequent than helping, though more children comforted when only low engagement was required (Low = 31/42 (73.8%), High = 18/42 (42.9%)). The tasks differed in terms of speed-of-response ($F(2.3, 36.7, G-G) = 6.6, p = .003$), and post hoc analysis revealed that children responded most slowly in the high engagement comforting task. Together, the results suggest that though the level of required social engagement may affect children's willingness to act prosocially to some degree, recognizing possible prosocial interventions to others' emotional needs may play a stronger role.

2-E-89 Teaching children merit and equality through storybooks and video testimony

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Are children's fairness preferences susceptible to the influences of social communication? Previously, we found that direct verbal instruction ("testimony") exerts a significant influence on children's tendencies to distribute resources based on equality or based on merit. However, we did not find a similar effect for storybooks involving beavers deciding how to divide wood. In this new research, we utilized carefully matched storybooks and video testimony to more directly investigate whether the format of social communication matters when the difficulty of transfer is made equivalent across formats. The contents of an illustrated storybook and videotaped testimony were equated, such that the lessons were identical both in their abstract appeals and in their concrete details. Participants (6- to 8-year-olds, current $N = 75$, data collection nearly complete) were pretested for their initial fairness preference, presented with an intervention that opposed this preference, and were post-tested immediately and again after a delay of 2-4 weeks. Results indicated that participants were equally likely to be swayed by storybooks (45%) and testimony (49%), $p = .759$, but were more influenced by equality appeals (61%) than by merit appeals (36%), $p = .034$. This pattern of results remained stable after a delay. Overall, brief social communication is effective in altering children's fairness preferences, and change is differentiated more by content than by format.

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2-E-90 Being responsive to reasons: How children revise their beliefs in light of new arguments

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One key aspect of rationality is the ability to appropriately incorporate novel reasons, even if they contradict prior beliefs. Previous research has shown that even young children distinguish strong from poor reasons. However, very little is known about whether and how young children revise their prior beliefs in light of new arguments. In Study 1, we first assessed at what age children distinguish between strong and poor arguments. 3-, 4- and 5-year-olds were presented with two wooden boxes and were told that only one of which contained a reward. Then they watched a video in which one puppet gave a strong argument for one box, whereas the other puppet gave a weak argument for the other box. 4- and 5-year-olds aligned their choice of box with strong arguments, whereas 3-year-olds were at chance. In a 2x2 design, Study 2 varied the strength of children's prior beliefs (strong or weak) and the new arguments children were exposed to (strong or weak). 4- and 5-year-old children formed a belief about the reward location supported by strong evidence (one box was heavier than the other) or no evidence (equally heavy). Subsequently, children saw a video in which a puppet gave a strong or a weak argument favoring the opposite reward location. We found two main effects. First, 4- and 5-year-olds were more likely to revise their initial belief when it was based on weak evidence. Second, 4- and 5-year-olds rather changed their belief when presented with strong arguments. Taken together, these studies suggest that children consider both the strength of novel arguments and the quality of initial evidence when revising their beliefs.

2-E-91 Training differences predict dogs' preferences for prosocial others

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Humans evaluate others' behavior on a variety of different dimensions, including morally. For example, humans of all ages show a preference for prosocial others over antisocial others. The tendency for infants as young as 8-months old to prefer prosocial others over antisocial others occurs in a variety of contexts (Hamlin, 2014), and negative evaluations of antisocial others have been documented through the use of a variety of paradigms (Hamlin et al., 2011). While these tendencies are well-documented in the human species, less is known about the uniqueness of these preferences. Here, we explore this question by testing prosocial preferences in one non-human species: the domesticated dog. Given the ubiquity of dog-human social interactions, it is likely that dogs display human-like social evaluation tendencies. Unfortunately, prior research examining social evaluation in dogs has produced mixed results. To assess whether differences in methodology or training account for these contrasting results, we tested two samples of dogs with different training histories on an identical social evaluation task. Trained agility dogs approached a prosocial actor significantly more often than an antisocial actor, while untrained pet dogs did not display a preference between actors. We suggest that while dogs may demonstrate preferences for prosocial others in some contexts, their social evaluation abilities are less flexible and less robust compared to those of humans.

2-E-92 The relationship between socioeconomic status and false-belief understanding: New evidence from a low-demand elicited-response task

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Performance on traditional elicited-response false-belief tasks is correlated with socioeconomic status (SES; Devine & Hughes, 2018), with some studies finding that low-SES children pass elicited-response tasks a year later than more advantaged children. However, it is unclear whether low-SES children's difficulties stem from delays in the ability to represent beliefs or issues coping with the significant processing demands that these tasks impose (Setoh, Scott, & Baillargeon, 2016). To test these possibilities, low-SES preschoolers completed two traditional elicited-response tasks (Baron-Cohen et al., 1985; Gopnik & Astington, 1988) as well as the low-demand elicited-response task devised by Setoh et al. (2016). The latter task has reduced inhibitory and response-generation demands and is passed by higher income children at 2.5 years of age. Children performed at chance on the traditional tasks, but they performed reliably above chance on the low-demand task (78% correct responses). We next tested equal numbers of low- and high-SES 2.5-year-olds with the low-demand task. Both SES groups performed reliably across chance, and performance did not differ across groups. These results suggest that low-SES toddlers and preschoolers can represent false beliefs, but they have difficulty with the demands imposed by traditional elicited-response tasks. When these demands are sufficiently reduced, their performance on elicited-response tasks does not differ from higher SES children.

2-E-93 Infants' perception of the moral status of irrational individuals

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Research with adults indicates that individuals with reduced cognitive competence are often treated as though they have fewer moral rights. Building on prior work that infants (a) can detect whether individuals are behaving irrationally and (b) possess an expectation of fairness, we asked in two violation-of-expectation experiments whether 16-month-olds would expect an irrational individual to be treated fairly. To start, while E1 and E2 watched, E3 behaved either irrationally (e.g., reached for an object inefficiently, or reached for an object inconsistent with her goal; irrational condition) or rationally (rational condition). Next, E1 divided resources between E1 and E3 either equally or unequally, favoring E2. In each experiment, infants in the rational condition looked significantly longer at the unequal than at the equal distribution, whereas infants in the irrational condition looked equally at the distributions. Thus irrational individuals appear to lose some of their moral rights, including that to fair treatment.

2-E-94 Preschoolers' moral judgments of those who hinder antisocial others

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Research Question: While helping is typically prosocial and hindering is typically antisocial, this is not always the case. Instead, there are contexts in which unhelpful actions are evaluated positively (e.g., when punishing wrongdoers). This poster explores whether preschoolers' moral judgments are sensitive to the context in which helping/hindering actions are performed (see Li & Tomasello, 2018). Methods and Results: Ninety-six 3 and 4-year-olds saw either a prosocial or antisocial character, who helped/broke a third-party's block tower. All children then saw the prosocial/antisocial character play with and subsequently drop a ball, which was returned by the helper and stolen by the hinderer. When asked which character "did the right thing", children selected the helper over the hinderer, regardless of

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whether he was helping the prosocial/antisocial individual (all $p < 0.025$). This poster will also report children's acceptability ratings of the helper/hinderer's action and the results of a follow-up experiment featuring different helping/hindering actions.

2-E-95 Mentalistic social cognition in context: 15-month-olds' evaluations of helpers based on their mental states in means-end sequences

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Imagine that a child tries but fails to open a box that contains a toy, and then the toy in the box is switched with a different toy in a second box. What would be most helpful to the child: opening the first box, even though the toy inside is now different; or opening the second box, which has the original toy? What would an agent need to know to help the child appropriately with respect to the child's goal? By the end of the first year of life, infants demonstrate an impressive capacity to reason about agents. By 12 months, infants understand action in context, reasoning that agents open boxes as a means to the end of accessing their contents (Woodward & Sommerville, 2000). By 10 months, infants engage in mentalistic social evaluation, preferring agents who provide a protagonist with its preferred vs. non-preferred toy only if the agents know the protagonist's preference (Hamlin et al., 2013). The present studies integrate these two lines of research to ask whether infants engage in mentalistic social evaluation in context. Specifically, we examine whether 15-month-olds: (i) attribute to others an understanding of a third-party's action in means-end sequences; and (ii) evaluate others' moral behavior with respect to the third-party's goal. In two studies, infants see two boxes, each with a unique toy. In familiarization trials, a protagonist tries but fails to open one box. Two helpers help the protagonist to open the box, and the protagonist grasps the toy inside. Following familiarization, infants see the two toys switch positions, such that the original box that had been opened now contains a new toy, and the other box contains the original toy. In test trials, the protagonist jumps between the boxes, as though calling for attention. One helper opens the original box with the new toy, whereas the other opens the second box with the original toy. In each study, we assess infants' preferences for the two helpers. The critical distinction between the studies concerns the helpers' perceptual access to the toys. In Study 1, the boxes are transparent and the helpers are present as the toys switch positions. By contrast, in Study 2, the boxes are opaque and the helpers are absent as the toys switch positions. Thus, although infants know of the switch in toys in both studies, they can only accurately attribute knowledge of the switch to the helpers in Study 1. In Study 1, 21/24 infants reached for the helper who opened the new box with the original toy. These data suggest that infants evaluate helpers based on whether they help with the end (the original toy), not the means (opening the original box), of the original means-end sequence. Data collection for Study 2 is ongoing, on track for sharing results at CDS 2019, and is important to understanding how infants reason that others represent a third-party's goal in means-end sequences. In Study 1, infants could have: only inferred the protagonist's goal and evaluated the helpers in relation to that goal; or only chosen the helper who had helped with the end of the means-end sequence because the helper had been present as the toys' positions had switched, and could know which box contained the original toy. In Study 2, the helpers cannot have knowledge of the switch in toys. If infants' social evaluations incorporate others' mental states, then if the helpers do not have the opportunity to know of the switch in toys, infants' preference should either disappear or reverse in Study 2.

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2-E-96 Fairness reexamined

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Young children distinguish between moral norms and conventional norms (Smetana, 1984). In existing research, fairness-related norms are by definition considered part of the moral domain. Yet fairness understanding emerges late in development and is culturally variable (Curry et al., 2019), raising the possibility that fairness may not fall squarely in the moral domain. We examined whether children see fairness as a moral or conventional norm, or somewhere in between. In Study 1, 3.5- and 6-year-olds (N=96) rated all three transgressions as being similarly bad. In Study 2, 6-year-olds (N=33) rated the seriousness in the following order: Moral > Fairness > Conventional > Control, and each was different from the others, $p < .001$. A second, forced-choice procedure revealed that most 6-year-olds (73%) grouped Fairness with Moral rather than Conventional, $p = .009$. This is the first evidence that children may not equate fairness norms with harm-based moral norms, pointing to the need for a more nuanced approach to children's understanding of moral norms.

F – Social cognition and social learning

2-F-97 Children's understanding of dominance and prestige in China and the UK

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Social rank comes in two forms: dominance (rooted in force or threat of force), and prestige (rooted in merit and influence) (Henrich & Gil-White, 2001). However, children's understanding of this, and how cultural environments shape it are understudied. In China and the UK, children (5-7 years, 9-12 years, $n=40/\text{age \& country}$) saw characters in three roles: subordinate (Sub), dominant (Dom), and prestigious (Pres). In Exp. 1, all children inferred rank from dominance and prestige cues. Further, older children (and to some extent younger ones) inferred that Sub would approach and like Pres, but fear Dom. Ethnographic evidence from China shows the value of prestigious individuals yielding to others, even those lower than themselves. So in Exp. 2 and 3, we showed adults and children cases of resource conflict (Sub vs. Dom; Sub vs. Pres), and asked who would win. Adults predicted that Dom and Pres would win, but Chinese adults were less likely than British adults to do so in the prestige case ($p < .01$). Younger children in both countries answered at chance levels (51%). Older children in the two countries responded differently from each other ($p < .05$). Those in the UK thought that high-ranking characters would win (76%, $p < .0001$), while those in China were at chance (59%). Chinese children's explanations indicate they are grappling with complex norms of who should yield and when. Overall, we provide evidence for a culturally-influenced aspect of social rank understanding.

2-F-98 The impact of gender and race on children's developing understanding of career-related traits

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Research has indicated that from birth, adults treat children differently based on gender, (Herbert & Stipek, 2005) and such differences are associated with children's judgements about their own competency (Lee, et al 2015; Shaprio & Williams 2012). In the current study, we explore the impact of gender and race on children's developing inferences about skills that are important for specific careers.

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105 5-8 years old children were invited to indicate which of two differently-gendered children excelled at 4 career-relevant skills (building, running, teaching, hairstyling). Children also indicated why they chose the particular child. To explore children's judgments, we conducted 4 separate binomial logistic regressions for children's judgments of each career-related skill separately with Age, Gender, and Race as predictors. Results indicated a main effect of Gender for building ($\beta = 1.19$, $SE = 0.53$, $p = 0.02$), running ($\beta = 1.14$, $SE = 0.52$, $p = 0.03$), and hairstyling ($\beta = 1.47$, $SE = 0.55$, $p = 0.01$). Girls were more likely than boys to indicate that the female character was "better" at the career-related skill. For teaching, there was a Gender x Race interaction ($\beta = -2.45$, $SE = 0.99$, $p = 0.01$). Follow-up binomial regression models on each gender group separately indicated an effect of Race on girls' responses ($\beta = 2.45$, $SE = 0.83$, $p = 0.003$) but not on boys' ($\beta = -0.12$, $SE = 0.61$, $p = 0.86$). Black girls were more likely to indicate that the female character was "better" at teaching than White girls. No other main effects or interactions were significant. We discuss implications of these findings on children's future judgments of trait-based abilities.

2-F-99 When constraints become insignificant: Children discount the influence of physical constraints when actors behave stereotypically

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Children's social group stereotypes are powerful schemas that guide their inferences about group members' inherent preferences. At the same time, children understand that actors may behave in ways that do not reflect their actual preferences because they are physically constrained to certain choices. In this study, we examined whether children appear to rely on group stereotypes (girls like pink) more than information about physical constraints (access only to pink options) when making preference inferences about an actor who behaved stereotypically (a girl who chose pink). In Experiment 1, children ($N = 33$; 5-8 years) observed a girl choosing a pink cake over a blue one either in a context in which she could reach both cakes (No Constraint) or could only reach pink (Constraint). Despite being physically constrained to pink in the Constraint condition, children were equally certain across both conditions that she preferred the pink cake over blue (Figure 1, Exp 1). This discounting of physical constraints did not occur for gender-neutral behavior; children in Experiment 2 ($N = 32$) who observed the girl choosing an orange cake over yellow were less certain that choice reflected an actual preference when she was constrained to orange compared to when she chose orange freely (Figure 1, Exp 2). Taken together, these results suggest that group stereotypes may have more explanatory power in children's preference inferences than environmental factors like physical constraints.

2-F-100 It is not just about attaining the goal: Infants' cooperative competence is shaped by their joint attention abilities and the social context in which cooperation occurs

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Initiating joint attention (IJA) is key for cooperative success. However, daily cooperative competence requires more than simply achieving a shared goal; the social context is also critical to cooperative success. Thus, examining how individuals cooperate and the factors that contribute to an effective cooperative social context is essential to understanding human cooperation. The present study examined if infants' ($Mage = 14.30$, $SD = 0.63$, $N = 210$) IJA (in a non-cooperative task) relates to successful cooperative actions and social context (affiliative and antagonistic behaviours) during cooperative tasks

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with an adult. Contrary to past research, IJA was not related to cooperative success. However, IJA was positively related to infants' affiliative ($r(106) = .23, p = .018$) and antagonistic behaviour ($r(100) = .23, p = .019$) during cooperation. Infants who demonstrated more IJA in a non-cooperative task were more likely to produce affiliative and antagonistic behaviours in cooperative tasks. Surprisingly, negative relationships were found between cooperative success and affiliative ($r(166) = -.16, p = .044$) and antagonistic ($r(166) = -.24, p = .002$) behaviours, suggesting that infants successful at attaining shared goals were less likely to show affiliative and antagonistic behaviours while doing so. Our findings suggest that infants' IJA shapes the social context of cooperation and that affiliative and antagonistic behaviours may interfere with infants' cooperative success.

2-F-101 Socio-cognitive and environmental processes involved in perspective-taking development in young children

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Learning to understand other people, particularly that others' perspectives can differ from one's own, is a cornerstone of social cognition. Perspective-taking (PT) develops in the first years of life: Children pass level 1 PT tasks at 24 months and level 2 PT tasks at 36 months (Moll & Tomasello, 2006; Moll & Meltzoff, 2011). Yet, it is unknown which socio-cognitive skills and environmental factors are linked to PT. Research with adults has shown that socio-cognitive skills like inhibition of imitation (but not general inhibition) affect PT (Santesteban et al., 2012). Similarly, adults' social environments, in particular social network size, enhances PT (Stiller & Dunbar, 2007). To address whether these factors affect children's PT skills, the present preregistered study examines socio-cognitive and environmental processes underlying level 1 visual PT in 3-year-olds. Individual differences in children's explicit and implicit PT are assessed in relation to inhibition of imitation and general inhibition. Additionally, children's social networks are examined in conjunction with PT. PT is measured with a communicative, behavioral task in which children choose one of two identical toys to give to an experimenter. Both toys are visible to the child but one is hidden from the experimenter's perspective. Children are asked to give the toy the experimenter "can see" or "does not see." PT skills are quantified using children's overt (choosing target toy) and implicit (eye gaze to target toy) responses on both trial types. Additionally, inhibition of imitation (social Stroop task) and general inhibition (Go-NoGo) skills are assessed in relation to PT. The structure of children's social environments is also measured using the Infant Social Relationship Questionnaire (Burke & Woodward, in prep), which quantifies the number of people in each child's social network. Results demonstrate that 3-year-olds ($N = 36$) systematically choose the correct toy on "can see" trials but not on "does not see" trials via overt responses. Yet, children's implicit responses suggest that children do account for another's perspective when it differs from their own. Additionally, children more affected by another person's actions (i.e., those poorer at inhibiting imitation) show equally good overt performance on both PT trial types, while children not affected perform more poorly on "does not see" trials. This relationship is not seen for general inhibition. Children with smaller social networks also perform worse on the more difficult "does not see" trials. Forthcoming results from a longitudinal study (data collection ongoing) will explore continuity in PT skills between ages 3 and 4. Results from this study have implications for understanding socio-cognitive and environmental processes supporting PT in early childhood.

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2-F-102 Is she a good teacher? Children learn to use representational gesture as a marker of a good informant

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When a teacher produces informative, representational hand gestures during a lesson, children learn more. But are young learners aware of this phenomenon? In the current study, children (n=342, ages 4-12 years) watched short video clips in which actresses made statements that were either accompanied by representational gestures, rhythmic beat gestures, or no gestures. After each video trial, children were asked either "Who do you think would be a good teacher?" (Informative condition, n=179) or "Who do you think would be a good friend?" (Control condition, n=163). For the Informative Condition, children's age was positively correlated with the likelihood of selecting the actress who used representational gesture ($R = 0.75$, $p = .018$) such that older children were more likely to identify a person who used representational gesture as "a good teacher" (Figure 1). Notably, this correlation was not statistically significant in the Control condition ($R = .48$, $p = .199$). These results suggest that as children develop, they are more likely to use representation gesture as a marker of a good informant. Additional analyses will investigate whether individual differences in children's propensity to see ambiguous movements as gesture moderates the relationship between age and the likelihood of selecting the representational gesturer as a good teacher.

2-F-103 Miracle or magic? Developmental patterns in Iranian children's judgments of reality

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How do children know what is real, fantastical, or miraculous, and what is the role of exposure to religion? Previous research with children exposed to religious teachings in the U.S. showed that with more exposure, children were more likely to judge fantastical and religious story characters as real (Corriveau et al., 2015). Similarly, 5- to 6-year-old Iranian children tended to judge fantastical figures as real, at similar rates as U.S. children with religious exposure (Davoodi, Corriveau, & Harris, 2016). In the current project, we presented 5-7- and 9-11-year-old children in Iran, where almost all children are exposed to religion, with fantastical, extraordinary, Koran, and real stories. After each story, children were asked to categorize the character as either real or pretend. Mixed-effects binomial logistic models showed that children were more likely to categorize realistic stories as real, as compared to stories from the Koran ($B = -0.85$, $SE = 0.27$, $z = -3.17$, $p = 0.001$). Compared to younger children, older children clearly differentiated between realistic and magical stories ($B = -1.82$, $SE = 0.49$, $z = -3.71$, $p < 0.001$). With age, Koran stories were also increasingly distinguished from magical ones, with magical stories rated as pretend more frequently ($B = -1.87$, $SE = 0.46$, $z = -4.02$, $p < 0.001$). In sum, we found that children in Iran clearly distinguish realistic stories from other types of stories that defy physical regularities. Nevertheless, they do not generally judge stories from the Koran as pretend. These findings add to previous literature documenting the role of religious exposure in the developing ability to distinguish reality from the miraculous.

2-F-104 Parents' question-asking during children's physical and digital spatial play

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Children benefit from guided play with adult scaffolding (Weisberg, Hirsh-Pasek, & Golinkoff, 2013), such as question-asking. Parents commonly ask pedagogical questions of their children (Yu, Bonawitz, & Shafto, 2017), and such questioning supports learning (Yu, Landrum, Bonawitz, & Shafto, 2018). We examined question-asking during mother-child play with physical spatial toys (Minecraft physical blocks and tangram puzzles) and matched digital games (Minecraft and Lumio Dragon Shapes). Preliminary coding ($N = 10$) shows that mothers asked more questions overall during physical ($M = 38.90$, $SD = 18.22$) than digital play ($M = 23.20$, $SD = 14.56$), $t(9) = 2.51$, $p = .034$. Similar results were observed for the number of pedagogical questions during physical ($M = 7.10$, $SD = 6.28$) and digital ($M = 3.50$, $SD = 5.72$) play, though the difference did not significantly differ, $t(9) = 1.52$, $p = .163$. Further analyses will include the full sample ($N = 64$, collected but not yet coded), and analyses of additional question types. The poster will discuss the implications of this work for understanding how parent questioning can influence children's playful learning and how interactions differ between physical and digital play.

2-F-105 Are converts likeable?: Children's and adults' views of those who change social groups

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Conversion-moving from membership in one social group to another-is ubiquitous, yet little work has explored children's or adults' thinking about changing social groups. The present study investigated adults' and children's expectations of how conversion might influence people's social preferences. 100 adults and 103 children (ages 5 to 10 yrs.; mean 7 yrs. 11 mos.) were told about two specific members of a novel group; one character was said to have recently converted from one group to another while the other had been a member of that same group their entire life (see Figure 1). Subsequently, participants were asked which of the two group members an ingroup member would prefer, which an outgroup member would prefer, and who the participant themselves preferred. Children and adults alike reported that a member of the characters' ingroup would prefer the lifelong group member more often than chance (binomial p 's $< .001$), and both children and adults did not display a clear preference themselves for either group member (p 's $> .1$). However, children reported that the outgroup member would prefer the converted group member (who was said to have previously been in the outgroup member's group) more often than chance ($p < .001$), whereas adults were at chance in their expectations for the outgroup member ($p > .1$). As early as in kindergarten, children make inferences based upon conversion. Ongoing work asks whether these intuitions change in the presence of between-group competition.

2-F-106 Transgender children's recall for gender-typed images

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Gender Schema Theory (GST) posits that children are attuned to learning behaviors deemed appropriate for their gender. Evidence comes from privileged recall for actions that are stereotypical for their gender. GST argues these responses are driven by children's internal sense of gender identity. Yet, this is difficult to empirically demonstrate, as most children are also socialized as the same gender. We aimed to delineate these factors by examining gender-relevant memory in transgender children, whose current gender is at odds with their initial rearing. To understand whether transgender children similarly show privileged recall for their current gender, or whether their recall favors the gender they were initially reared as, we recruited 87 transgender and 84 cisgender children. Participants saw images of girls and boys engaged in stereotypical or counter-stereotypical behavior, and were tested for recall of the

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pictures. Children showed better recall for same-gender stereotypical than counter-stereotypical images, $p=.016$, but no difference for opposite-gender stereotypical and counter-stereotypical images, $p=.062$. Effects did not interact with whether participants were transgender, $p=.203$, suggesting that children's internal sense of gender and/or their current gender of rearing, rather than initial gender of rearing, impact children's memory. These findings add to prior research showing that transgender children's gender cognition resembles that of cisgender children.

2-F-107 Preschoolers neural responses to emotional faces moderates the relation between theory of mind and prosocial behavior

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Theory of mind (ToM)--understanding that other's thoughts, beliefs, desires, and intentions are different from one's own and that internal mental states motivate behavior--has been proposed as one foundation for children's prosocial behavior. However, empirical findings examining relations between ToM and prosocial behavior have been mixed: some studies show that ToM is related to helping, cooperating, and comforting (Imuta et al., 2016) while others show ToM is related to bullying (Smith, 2017). The present study examines an ERP correlate of face processing, the N170 (recorded as children viewed happy, angry, fearful, and neutral faces) and how this neural signature relates to children's prosocial behavior and ToM (assessed via standard behavioral tasks and questionnaires; e.g., Wellman & Liu, 2004). Data collection is currently ongoing. In a preliminary sample of 13 participants, better ToM was associated with more prosocial tendencies, but only in children who had larger N170 mean amplitude to happy faces (compared to neutral face amplitude). Additionally, children's ToM was positively correlated with a neural measure of "emotion sensitivity", which examined the difference between N170 mean amplitude to a fully expressed emotion (100% intensity) versus a less intensely expressed emotion (40%), $r(13) = .670$, $p = .012$. Together, these findings indicate that concurrent neural processing of emotional faces may offer insight into the relation between children's understanding of other's mental states and their motivation to help others.

2-F-108 Advanced theory of mind and task-switching in adolescents with and without autism spectrum disorder

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Advanced theory of mind (aToM) and task-switching were examined in high-functioning adolescents with autism spectrum disorder (ASD) and an age-matched comparison group. Computerized versions of the Flexibility and Automaticity of Social Cognition task (FASC; Hayward et al., 2016) and the DCCS (NIH Toolbox) were given. The FASC requires explanation of cartoons of social situations varying in ambiguity and language-use. For the FASC, groups did not differ on total lag-time (delay in responding), number of mental-state terms, or unique responses. Overall, the ASD group provided fewer typical first responses. Both groups provided more typical first responses and mental-state terms for unambiguous than ambiguous cartoons, and for verbal than non-verbal cartoons. More unique responses were also provided for verbal than non-verbal cartoons, and participants waited longer to respond to ambiguous than unambiguous cartoons. Groups' lag-times were comparable for ambiguous cartoons, but the ASD group had longer lag-times for unambiguous cartoons. Groups did not differ on DCCS, with task-switching predicting total mental-terms and total lag-time in the comparison group. Similarity between

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groups was not surprising given that the ASD group was high-functioning. However, group differences in lag-time, total common first responses, and associations between task-switching and the FASC suggest that the FASC can offer a more nuanced understanding of aToM differences across unique populations.

2-F-109 Young children prefer to learn from, but do not trust, smart devices

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The increase in the presence of smart speakers in homes raises important questions about how interactions with such devices impact child development. How do children use smart speakers? How do they judge the accuracy of the information they provide? In the current study, we investigated how children learn from smart devices. Based on the paradigm by Reyes-Jaquez & Echols (2013), we presented 30 5- to 6-year-olds with unfamiliar animals and asked them to ask a human or the Amazon Echo for more information about the animals. After hearing from both agents, we then asked the participant whose information they trusted. A questionnaire was administered to the parents to assess the effects of prior experience with the Echo. We used a binomial mixed-effects regression with technology experience (usage of interactive devices the day before in minutes) as a fixed effect and subject and item as random effects. Children were significantly more likely to request to learn from the Echo (beta = -1.335, SE = 0.422, $z = -3.160$, $p = 0.002$), and technology experience did not significantly explain request choice, (beta = 0.00639, SE = 0.00518, $z = 1.234$, $p = 0.217$). However, children were equally as likely to trust the Echo and the human (beta = -0.423, SE = 0.286, $z = -1.479$, $p = 0.139$; see Figure 1). These findings suggest that although children are drawn to interact with smart devices, they may not see them as a reliable source of information.

2-F-110 Labels increase acceptance of foreign and unconventional foods in children

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By 5 years of age, children negatively evaluate foods and people that deviate from conventional eating practices (DeJesus, Gerdin, Sullivan, & Kinzler, 2019). Holding strong norms about food choices can be problematic when people from diverse cultures with different eating habits must coexist. One way to make children more accepting of foods from different cultures is to describe unfamiliar foods with a label. Labels could help children view unfamiliar foods not as norm violations, but as a separate category of foods that were created intentionally and are sanctioned by others. The present study investigated whether labels affect 4- to 7-year-old American children's acceptance of unfamiliar foods. Children ($N = 48$) rated on a 5-point scale how okay it is to eat unfamiliar foreign foods (e.g., ambuyat, a dish from Brunei), familiar western foods (e.g., mac and cheese), unconventional food combinations (e.g., milk and mustard), conventional food combinations (e.g., milk and chocolate syrup), and nonfoods (e.g., pencil). Children were randomly assigned to hear the foods described with a label (e.g., "This is wood pulp mixed with water. This is called ambuyat") or without a label (e.g., "This is wood pulp mixed with water"). A significant interaction between label and food type ($F(4,184)=2.82$, $p=.03$) indicated that children were more accepting of unfamiliar foreign and unconventional foods when provided a label compared to no label, $ps<.05$. Labels did not affect acceptance of familiar western foods, conventional foods, or nonfoods, $ps>.117$. Our findings show that labels increase acceptance of unfamiliar foods in children.

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We are currently investigating what aspects of labels - category, intentionality, or norms - influence this acceptance.

2-F-111 How do communicative cues shape the way that dogs encode objects?

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Our human capacity to efficiently learn from one another unparalleled in any other species. Some scholars argue that this ability is supported by an early-emerging expectation that communicative cues will convey generic information (Csibra & Gergely, 2011). In the current studies, we examine whether this expectation about generic information is unique to humans by investigating another species that readily attends to human cues - domestic dogs. To address this question, we adapted a violation of expectation paradigm previously used with human infants to examine whether communicative cues lead dogs to selectively encode generic, kind-relevant information about objects (e.g., shape). Prior work demonstrates that human infants are more likely to notice unexpected changes in kind-relevant information in communicative contexts (i.e., when an agent points to the object; Yoon et al., 2008). In contrast, dogs in the current studies were no more likely to notice kind-relevant changes in communicative contexts than non-communicative contexts, either in Study 1, $t(81) = 0.85$, $p = .398$, or in Study 2, $t(44) = 0.41$, $p = .684$. Together, these findings suggest that although dogs attend to human communicative cues, these cues do not shape the way dogs encode objects. More broadly, this lends support to the claim that our early-emerging generic expectation uniquely supports our human capacity to efficiently learn from one another.

2-F-112 Children's affiliation decisions when group membership and shared preferences conflict

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Children value group loyalty. They favor those who support the ingroup and keep group confidences. Children also value similarity. Shared likes guide their preferences for friends and resource recipients. Independently each supports social reasoning; however, these dimensions need not accord. How do children reason about affiliation when group membership conflicts with personal tastes? We introduced 3-8-year-old children ($N=495$) to two novel groups, each with a distinct food preference, and assessed their affiliation predictions and moral judgments. Study 1 participants indicated which group "targets" should affiliate with (Fig 1). On critical trials targets belonged to one group, but shared a food preference with the other. 3-4-year-olds selected the ingroup; however, 7-8-years selected the preference-matched-outgroup, $t(65) = 5.89$, $p < .001$. Study 2 participants viewed targets affiliate with the ingroup or the preference-matched outgroup then indicated whether the affiliation would result in positive or negative feelings. Young children rated the target's emotion as more positive following ingroup affiliation, $t(94) = 2.09$, $p < .05$; older children rated the target as more positive following outgroup affiliation, $t(98) = -2.52$, $p < .01$. Study 3 participants witnessed the emotion resulting from targets' decisions and indicated whether it was right or wrong. Only older children endorsed outgroup affiliation when it resulted in positive feelings, $t(188) = 2.04$, $p < .05$. These studies show that young children are less permissible of outgroup affiliation, even when shared tastes are made salient. With age children become more accepting of outgroup affiliation when tastes align.

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2-F-113 Children's interpretation of confidence cues: Situational vs individual knowledge

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It has been widely demonstrated that children prefer to learn from confident individuals over their hesitant counterparts. However, little is known about how children interpret confidence cues. The main goal of the current investigation is to explore whether preschool-aged children interpret confidence cues as indicators of the informant's situational knowledge (i.e., specific to the situation at hand) or of their individual knowledge (i.e., general knowledge). Two to five-year old children (Study 1; 32-38 months, N=63, Study 2; 46-71 months, N=49) saw informants who were either consistent (i.e., confident-confident or hesitant-hesitant) or inconsistent (i.e., confident-hesitant or hesitant-confident) when demonstrating different levels of confidence. Replicating previous findings, children performed above chance (i.e., siding most frequently with the confident individual) in study 2 ($M=3.612$, $SD=1.497$, $t(48)=5.199$, $p<.000$). Surprisingly, they did not have such preference in study 1 ($M=2.730$, $SD=1.752$, $t(62)=1.042$, $p=.301$). Results also indicate no preference to learn from a consistent over an inconsistent informant (Study 1; $t(61)=-1.247$, $p=.217$, Study 2; $t(47)=1.062$, $p=.294$) suggesting that older children strictly interpret confidence cues as indicators of situational knowledge (i.e., preferring the currently confident individual) whereas younger children do not seem to pay attention to these types of credibility cues.

2-F-114 How do children evaluate in-group favoritism in requests for help?

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When providing help, children care about both group membership and fairness. Young children show strong ingroup bias in their resource distributions (Dunham et al., 2011). Older children show more fairness in their own allocations (Misch & Dunham, 2018; Shaw & Olson, 2012) and also increasingly view biased resource distributions as unkind but likely (DeJesus et al., 2014). However, whether group membership influences solicitation of help across development remains an open question. Fairness is less relevant to soliciting help; selectively asking the ingroup does not give the ingroup "unfair" advantages. Also, groups may serve as boundaries for intrinsic obligations and generalized reciprocity (Rhodes & Chalik, 2013; Yamagishi & Kiyonari, 2000), suggesting that ingroup members may be likelier to accept solicitations of help. To investigate this, our preregistered study (ongoing, N = 57; target 168 by 9/1/2019) explores how children (ages 5-10) evaluate agents who either do or do not show ingroup bias when providing or soliciting help. Our key predictions are that, older children will negatively evaluate ingroup bias when providing help, but children across our age range will view ingroup bias as acceptable when soliciting help. The role of group membership in the solicitation of help is understudied in children but can yield important insights into how groups serve as boundaries for intrinsic obligations and generalized reciprocity.

2-F-115 The influence of visualizing the group on children's beliefs about group membership in STEM

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We examined the impact of visual group homogeneity on children's beliefs about group membership in science. 4-6-year-old children ($N = 62$) were assigned to one of three conditions, and were invited to view a scientist surrounded by a group of other scientists: an all-female group, all-male group, or a female scientist surrounded by males. We then measured children's persistence on a science task, as well as their trait inferences about the target scientist. Children in the all-female group persisted for more trials than children in the other two groups, $F(2, 58) = 3.13$, $p = 0.05$. Children's trait inferences were influenced by mixed-gender groups. Children who saw same-gender scientists (all-male or all-female) were more likely to judge the target scientist as hardworking, whereas children who saw the target female scientist within an all-male group judged her to be smart, $\chi^2(2, N = 62) = 9.55$, $p < 0.01$.

2-F-116 Pretty young things: The developmental roots of female objectification

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Objectification is a social-cognitive phenomenon that relegates girls and women to a non-human status (Fredrickson & Roberts, 1997). Though studies of female objectification traditionally utilize adult samples, research suggests that young children possess elaborated concepts of gender (Taylor et al., 2010). Do the roots of objectification, then, lie in early childhood? To investigate, we developed a novel measure of objectification for adults (university undergraduates; $N = 78$) and children (4-7 years old; $N = 65$) that probed physiological aspects of mental life (Weisman et al., 2017) and mental state attributions. In Task 1, only adults showed evidence of female objectification, assigning more human-like physiological traits to boys than girls ($p = .002$). In Task 2, the gender of the perceiver--not the target--influenced mental state attributions for both adults ($p < .001$) and children ($p = .007$), with female participants offering more mental state attributions than males. These findings reveal a complex trajectory of objectification that has roots in early childhood.

2-F-117 Contributions of academic efficacy and goal orientations to learning gains and interest during a challenging mathematics lesson

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Problem: Children's academic efficacy (AE) and learning goal orientations (LGO) are known to predict achievement (e.g. Ames, 1992; Honicke & Broadbent, 2016; Senko 2019). However, how AE and LGO shape in-the-moment engagement and learning is underexplored. In this study, we tested: (1) whether students' AE and LGO predicted learning gains from a single challenging math lesson, and (2) whether these same traits predicted students' enjoyment and desire to learn more. **Participants:** 197 diverse 5th grade students (40% Black; 28% White; 18% Multiracial; 14% Hispanic; 101 girls). **Procedure:** Session 1: Students completed the AE and LGO subscales from the Patterns of Adaptive Learning Instrument (Midgley et. al, 2000), and took a pretest. Session 2: Students viewed a challenging math lesson. Students completed a math posttest, as well as a measure of their enjoyment and desire to learn more. **Results.** AE predicted learning; students higher in AE showed larger learning gains ($\beta = 0.21$, $p < 0.01$), even after controlling for student's pretest score. AE did not predict either enjoyment or exploration intention. LGO, on the other hand, did not predict learning, but did predict exploration intention ($\beta = 0.29$, $p < 0.001$) and enjoyment ($\beta = 0.17$, $p < 0.05$). **Conclusions:** This pattern of results suggests that academic efficacy and mastery goal orientation may contribute to educational achievement outcomes through different pathways.

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2-F-118 The role of cross-classification in children's knowledge attributions and testimony evaluations

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Children appropriately consider many factors (e.g., knowledgeability) when evaluating the testimony of others. Although studies of selective trust often focus on informants that fit into two distinct categories (e.g., mechanic vs. biologist), people often hold numerous social roles. Using a selective trust paradigm, we investigated how cross-classification, (i.e., belonging to multiple categories) influences children's judgments of informant knowledgeability. Younger (N=35, Mage=5.03) and older children (N=35, Mage=8.06) were presented with videos of pairs of informants introducing themselves and naming an object. Informants included teachers, students, teacher-students, and teacher-cooks. Participants were asked which informant was correct and which was a better teacher. Although cross-classification did not influence children's testimony evaluations, both younger and older children recognized that a teacher has more relevant expertise in a teaching domain than a student, $ps < .01$. However, younger children also indicated that singly-classified teachers were better teachers significantly more often, $t(34)=2.68$, $p < .05$, than cross-classified teachers, illustrating that cross-classification diluted informants' perceived expertise (see Figure 1). These findings suggest that while cross-classification does not affect older children's knowledge attributions, young children may construe expertise as a limited resource that is distributed among the roles that an individual holds.

2-F-119 Children attribute fewer mental experiences to social group members described in generic terms

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The attribution of fewer mental states to social group members is an important facet of dehumanization and has consequences for moral judgements in adults (Waytz et al., 2010). Yet, little is known about the interplay between the cognitive biases and the cultural input that contribute to the development of potentially dehumanizing beliefs among children. We investigated whether subtle differences in language influences 5- to 10-year-old's mental life attributions to social group members. In the first study, children either heard generic ("Flurpies are.."; $n = 60$) or specific ("This Flurpie is.."; $n = 59$) descriptions about a novel group. They were then asked to rate the ability of a Flurpie to experience different physiological (e.g., feel pain) emotional (e.g., feel proud) and cognitive states (e.g., be aware; Weisman et al., 2017). Controlling for age and the variation in beliefs about between-group similarity, the results revealed that children in the generic condition attributed fewer physiological and emotional "experiences" to a group member compared to children in the specific condition. The results of a follow-up control condition ($n = 59$) confirmed that this difference was driven by decreases in mental experiences after exposure to generic input. This research informs social cognitive theories of the development of intergroup bias.

2-F-120 Effect of gender on selective trust in Brazilian preschool children

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The present study was the first to investigate a possible effect of informants' gender in Brazilian children's selective trust judgments. Sixty-three 3- and 4-year-old children (32 boys and 31 girls) participated. Following Taylor (2013), previous accuracy rates were pitted against informants' gender. Participants were distributed into four conditions. In the first condition (C1), the female informant labeled familiar objects correctly during four familiarization trials, but the male informant labeled them incorrectly. In the second condition (C2), the female informant provided inaccurate labels, whereas the male informant labeled them accurately every time. In a third condition (C3), both informants provided correct names for the objects. Finally, in the fourth condition (C4), both informants labeled the four objects inaccurately. Results from four test trials (when children had to choose one of the two informants to label novel objects) showed that children in C1 and C2 presented a clear preference for informants with a more reliable history, regardless of their gender (75% of participants in C1 and 68.8% in C2). When both informants had presented the same history of accuracy, most children preferred the same-gender informant (53.3% in C3 and 68.8% in C4).

2-F-121 Exploring predictors of The Awareness of Social Inference Test in women who experience traits relating to the Broader Autism Phenotype

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Women who experience traits relating to the Broader Autism Phenotype may have difficulty in social situations, perhaps especially those that involve non-verbal cues. We used the Social Responsiveness Scale (SRS-2), Broader Autism Phenotype Questionnaire (BAPQ), and Autism Diagnostic Observation Schedule (ADOS-2) to predict scores on the Awareness of Social Inference Test-Short (TASIT-S). In a second analysis, we used two items from the SRS-2 that deal with emotions to predict TASIT-S total scores. Results showed that subscales dealing with social affect explained 12.8% of the variance in TASIT-S total scores, with the Social Affect subscale of the ADOS acting as the largest predictor. SRS questions #38 (regarding responding appropriately to the emotional state of others) and #47 (laughing at inappropriate times) together predicted 20.9% of the variance in TASIT-S scores. However, SRS question #38 was the only significant predictor. These results suggest that difficulty responding to the emotional state of others is associated with difficulty reading non-verbal cues.

2-F-122 Does first-hand experience improve children's ability to make relative trust judgments?

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Children rely heavily on other individuals for information about the world. Learning from others allows children to gain information quickly, yet trusting others can also leave them vulnerable to deceit. Thus, it is vital that children learn to discriminate between sources with good and bad intentions. Our research aimed to understand children's ability to use information regarding others' intentions when making trust decisions. One limitation of selective trust research is that children's trust has typically offered children either first-hand information about an informant's intentions (e.g., they directly observe someone helping another person) or second-hand information (e.g., they are simply told someone is helpful). Therefore, study one examined children's selective trust when provided second-hand information about informants' intentions. In study two we tested whether receiving both first- and second-hand

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information facilitates selective trust in a helpful vs. tricky informant. Study 1: to investigate whether children selectively trust a more honest source, 3- and 4-year-olds ($N = 47$) searched for hidden stickers after hearing conflicting advice from two informants who differed in their intentions (were helpful versus deceptive). Both 3- and 4-year-olds discriminated between reliable and unreliable sources when asked who was "a good person to listen to," but only 4-year-olds selectively took advice from the more helpful informant. In contrast, 3-year-olds trusted sources indiscriminately, despite making correct verbal inferences about reliability. Study 2: we examined whether having children (3- and 4-year-olds, $N = 100$) experience informants' traits first-hand would help facilitate selective trust in the helpful over tricky informant. The procedure was identical to study one for children in the second-hand condition. In the combined condition (1st and 2nd hand info), children initially received 3 first-hand information trials in which they were asked to guess what animal was in a box after each informant offered advice: each informant gave consistently helpful or deceptive advice across trials. Children received feedback by peeking inside the box. The informants' intentions were then described as in the second-hand condition and the test trials followed. Overall, 4-year-olds trusted the helpful informant significantly more often than 3-year-olds (72% vs. 56%, respectively). The effect of condition (combined vs. second-hand condition) and the interaction between age and condition were not significant. Yet, 3-year-olds in the combined condition trusted the helpful informant over the tricky informant more often than chance, $t(26) = 3.32$, $p = .003$, in contrast to 3-year-olds in the second-hand condition who trusted at-chance levels, $t(25) = 1.00$, $p = .33$. Four-year-olds in the combined condition and second-hand condition trusted the helpful informant at above-chance levels ($ps = .001$ and $.009$, respectively). Overall, these findings suggest that by three years of age, children can verbally assess the reliability of sources who provide conflicting information. Subsequently, by four years of age, children selectively trust the more honest of two sources based on their relative reliability. Yet, when three-year-olds experience the informant's traits first-hand they reveal a fledgling ability to selectively trust a helpful over a tricky informant.

2-F-123 Knowledge and inhibitory control help 3-year-olds ignore incorrect machines, but not deceptive people

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Two studies explore the effect of individual differences (theory of mind, inhibitory control), the bias to trust human testimony, and personal knowledge on children's processing of deceptive information (Heyman et al., 2013; Jaswal et al., 2014). On 8 trials, 3-year-olds heard a deceptive person (Study 1, $n=33$) or saw a broken machine (Study 2, $n=40$) provide incorrect information about a hidden object's location, then searched. Half of children saw where the object was hidden, which conflicted with the provided information. The other half had no personal knowledge. In Study 1, children with knowledge searched randomly ($M = 3.82$, $SD = 3.00$), $t(16) = -0.242$, $p = 0.812$, and children without knowledge followed the deceptive person ($M = 2.44$, $SD = 2.34$), $t(15) = -2.67$, $p = 0.017$, $d = -1.38$. Individual differences did not predict correct searches. In Study 2 a machine replaced the deceptive person. This time, children with knowledge searched correctly ($M = 5.52$, $SD = 2.11$), $t(20) = 3.31$, $p = 0.004$, $d = 1.48$ and more often than children without knowledge ($M = 3.16$, $SD = 2.89$), $t(38) = -2.98$, $p = 0.005$, $d = -0.97$, who did not differ from chance, $t(18) = 1.27$, $p = 0.22$. Inhibitory control only predicted children's correct searches when they did not know where the object was hidden (Table 1). Having knowledge, or in its absence, having higher inhibitory control, helps children ignore incorrect machines, but neither knowledge nor individual abilities help them ignore deceptive people.

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2-F-124 What could have been done? Counterfactual alternatives to negative outcomes by religious and secular children

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Recent studies suggest that compared to children with a secular upbringing, children with a religious upbringing are more likely to judge miraculous and fantastical events as real (Corriveau et al., 2015). One implication of this finding is that exposure to miraculous content in the context of religious teaching might alter children's basic understanding of cause and effect, which might also be reflected in their counterfactual thinking (Harris et al., 1996). To test this hypothesis, we presented 73 younger (6-to 8-year-olds) and older (9-to 12-year-olds) children attending religious or secular schools in the USA (33 females, $M = 9.14$ years; $SD = 1.78$ years) with 3 scenarios involving an undesired outcome and asked them to judge whether each of the four alternative actions (i.e., human intervention, praying, wishing, magic) could have prevented the outcome for each scenario by saying 'yes' or 'no'. As seen in Figure 1, children's 'yes' responses shifted significantly by the type of alternative, $F(3,207) = 106.64$, $p < .001$, $\eta^2 = .61$. Overall, children thought that human intervention ($M = 2.64$, $SD = 0.53$) could have been more effective than praying ($M = 2.00$, $SD = 1.10$), which could have been more effective than wishing ($M = 0.82$, $SD = 1.09$) and magic ($M = 0.58$, $SD = 0.99$) in preventing the outcome. However, children attending to parochial schools were more likely than children attending to secular schools to judge that praying could have prevented the outcome, $F(3,207) = 4.01$, $p < .008$, $\eta^2 = .06$. These findings suggest that religious exposure does not necessarily alter children's understanding of natural causal laws, but instead teaches them that the impossible can occur only via divine intervention.

2-F-125 Gender as a cue to sharing preferences in 4-6-year-old children

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By the preschool age, children share fairly, and expect others to do the same (Sutter, 2007). While research outside of prosocial development has shown that children use gender as a cue in evaluating and interacting with others (e.g. Mulvey, Hitti, & Killen, 2010), little is known about how gender shapes children's beliefs about sharing. In the current study, we developed a questionnaire to measure gender stereotypes about sharing. We gave 4-6-year-olds ($N = 57$, $N_{\text{females}} = 34$) nine items in which they indicated who was more likely to do "X" (girls, boys, or same) when asked about sharing behaviors. We included items (Figure 1) about general sharing behaviors (items 1, 2, 6, 8), the participant's own play and sharing preferences (items 4 & 7), in-group sharing preferences (items 5 & 9), and a single item measuring which gender is nicer (item 3; for comparison). Children showed an in-group bias on most items such that children expected their own gender to be more likely to share (p 's $< .05$, controlling for age). However, on two items ("who would share a sticker with another boy in their class" and "who would need to be asked more than once to share"), children showed no gender bias choosing boys and girls (but not same) at similar rates. This study demonstrates that children's beliefs about sharing show in-group preferences. Results are discussed in terms of implications for vignette-based prosocial behavior studies given that extant research rarely considers gendered in-group biases.

2-F-126 Exploring the relation between demand for mutual gaze and hiding skills in young children

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Children younger than 5 years often claim not to see a person whose eyes are covered (Flavell et al., 1981; Moll et al., 2015). One hypothesis (Hypothesis 1) for this curious phenomenon is that children misunderstand the question by confusing the roles of perceiver (agent) and perceived (patient). Another hypothesis (Hypothesis 2) states that children understand the question correctly but have a bidirectional conception of seeing according to which eye contact is necessary for someone to see another. We tested these hypotheses experimentally (N = 32) by measuring children's denials of seeing someone whose eyes were obstructed along with their performance on a task requiring the distinction of agent and patient roles (testing Hypothesis 1) and their skills at "hide-and-go-seek" (testing Hypothesis 2). Preliminary results show that, as expected, most children (75%) negated seeing another whose eyes were covered; however almost all of them skillfully identified agent and patient roles (disconfirming Hypothesis 1). Children's hiding skills varied but were unrelated to their person perception judgments ($r = .01$, $p = .95$, disconfirming Hypothesis 2). Possible alternative explanations for children's negations of others' visibility outside of eye contact are discussed.

2-F-127 Children's perceptions of status at the intersection of race and gender

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By 6 years of age children associate males with higher status than females (Liben, Bigler & Krogh, 2001), and view White Americans as having higher status than Black Americans (Bigler, Averhart & Liben, 2003). However, little is known about how race and gender interact to influence children's thinking about status. We explored the influence of gender [race] on children's thinking about the relation between race [gender] and status. To test whether the tendency to associate males [Whites] with higher status than females [Blacks] is stronger for White males than Black males [White females], 96 5- to 8-year-old children viewed pairs of one high- and one low-status job (e.g., CEO/assistant) across 12 trials that varied the race [gender] of the targets. Participants were instructed to match photos of White/Black males/females to the job they thought each group of people should do. G-tests of goodness-of-fit indicated that children's tendency to associate males over females with high-status jobs differed based on the race of the targets, $p < 0.001$. However, the tendency to associate White over Black targets with high-status jobs did not vary based on the gender of the targets, $p = 0.187$. A second study using novel occupations to control for past exposure to different races and genders in the occupations is currently underway (N = 61). The findings suggest that children's thinking about race may influence how they reason about the relation between gender and status.

2-F-128 Do metacognitive strategies predict social selective learning in preschoolers?

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The cognitive mechanisms driving selective social learning in young children are currently unclear. It has been proposed that metacognitive skills are required to distinguish competent from incompetent informants by 5 years of age (Heyes, 2016). The main goal of the current study was to test this hypothesis. To do this, preschoolers (mean age = 3.99 months) were administered three tasks: a selective social learning task, a paired-associate learning task, and a metacognition task measuring

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explicit confidence judgments. The two latter tasks represented both domain-general and domain-specific abilities, respectively. Results from a linear regression showed that metacognition was a statistically significant predictor of performance of selective social learning, whereas paired-associate learning was not. These results provide support in favor of the view of selectivity in social learning that suggest that the underlying mechanisms of selectivity are domain-specific abilities by 4 years of age.

2-F-129 Fit to lead by all means? Boys but not girls associate positions of power with their own gender and race

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Across cultures there is a shared structure of social power (Sidanius & Pratto, 1999). Usually, power differentials stem from a legitimate basis (e.g., institutional hierarchies; French & Raven, 1959). However, power is also often tied to arbitrary social markers: Inequities still exist between members of different genders and racial groups (e.g., majority White male congress, Paxton et al., 2009; Riccucci, 2009). One argument is that imbalances persist, in part, because underrepresented individuals may not feel fit for power: Women perceive themselves as less competitive, qualified, and are more risk-averse than men when running for office (Lawless & Fox, 2012). Sensitivity to these issues might be present early: Children associate power with age and gender (Gülgöz, 2015), and race to job status (Bigler et al., 2003). In two experiments, we investigated the means by which children anticipate that members of different social groups gain power. Then, we tested whether gender predicted children's willingness to risk losing access to desirable resources so as to gain power. In Experiment 1, 62 6- to 10-year-olds (30 female, all White) saw sets of four equally attractive faces (gender trials: two male, two female; race trials: two White, two Black) and guessed who was in charge of granting prizes and permissions (i.e., acts indicative of power, Gülgöz, 2015). In phase 1, children heard that the person in charge at place X was in charge only due to reasons that had (e.g., did it before and was really good at it) or lacked (e.g., was pretending to know what to do) merit (counterbalanced within-subjects). In phase 2, children guessed which individual wanted to be in charge but was not picked, and so others said that this person would probably have to act questionably (cheat, lie) to be picked next time. Children's in-group favoritism (selecting same-race or gendered face) was evaluated by trial type (gender, race), age (months) and child gender (& Merit for phase 1). In phase 1, boys exhibited greater, above-chance, in-group favoritism than girls across race and gender trials, $F(1, 62) = 11.33$, $p = .001$ (Fig. 1). No age or merit effects were found. The same was true for phase 2, $F(1, 62) = 9.65$, $p = .003$. Thus, only boys systematically associated White as well as male individuals with power--regardless of whether it was obtained questionably. Did gender differences reflect children's awareness of actual societal inequities, or also indicate internalized beliefs about fitness to be in charge? In Experiment 2, 62 6- to 10-year-olds (32 female) could distribute candy between themselves and the experimenter. In this game, Player 1 (P1) was in charge of splitting 10 rolls of smarties, whereas Player 2 (P2) would simply take as much candy as P1 provided. To be P1 children had to find a coin hidden in 1 of 4 boxes, had only one chance, and if they failed the candy game was over. To be P2 nothing was needed, but they would not be in charge. Thus, children's initial player choices suggested their willingness to take risks to gain power (resource control). A comparable proportion of boys (44%) and girls (47%) were willing to attempt becoming P1, Fisher's test, $p = 1$. Across two studies, we show that early in life boys but not girls a) associate gender and race with power, regardless of the merit by which it is gained. Notably, this early social awareness b) does not appear to undermine children's motivation to seek positions of authority for themselves.

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2-F-130 Developmental changes in event-emotion matching across the first two years of life

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The ability to accurately predict another person's emotional response to an event is important for social-emotional development (Fine et al., 2006). However, the developmental trajectory of this ability is not well documented. Recent work suggests that infants between 14- and 18-months of age are able to match specific negative emotional expressions (e.g., disgust) to specific events (e.g., tasting novel food; Ruba, Meltzoff, & Repacholi, 2019). In contrast, while younger 10-month-olds infants expect positive events to elicit positive emotions, they do not expect negative events to elicit negative emotions (Hepach & Westermann, 2013; Skerry & Spelke, 2014). The current studies extend this work to document how event-emotion matching develops over the first two years of life. The current studies used similar methods to Ruba et al. (2019). Infants watched two videotaped events in which an Emoter interacted with another person and an object (e.g., a person gave the Emoter a desired toy). After two familiarization trials of one of the events, the Emoter facially and vocally expressed an emotion that was congruent with the event (e.g., happiness) or an emotion that was incongruent (e.g., anger). The video was then paused to provide a still-frame of the Emoter's facial expression, and infants' looking time was recorded. The same procedure was followed for the other event. If infants match specific emotions to specific events, they should look longer at the incongruent emotional expressions compared to the congruent expressions. In Study 1, 10-month-olds (N=60) expected that a negative event (having a desired toy taken away) would elicit a negative emotion (anger) rather than a positive emotion (happiness). However, in contrast to prior research, infants did not expect a positive event (receiving a desired object) to elicit a positive emotion (happiness) rather than a negative emotion (anger). In subsequent studies, we examined whether (a) 10-month-olds could link specific negative emotions to specific negative events, and (b) whether event-emotion matching abilities change between 10- and 14-months of age. In Study 2, 10- and 14-month-olds (N=60 per age) were presented with two negative events and two high-arousal, negative emotions (anger, disgust). Both age groups expected that losing a desired toy would elicit anger, rather than disgust. However, only 14-month-olds linked disgust, rather than anger, to an event involving a novel food. Study 3 provided additional evidence that 10-month-olds (N=60) did not link disgust to a novel food event. However, there was some evidence that 10-month-olds linked anger, rather than disgust, to an event involving an unmet goal. These studies are the first to demonstrate that, in the first year of life, infants are able to match negative emotions to negative eliciting events. Infants at this age are also beginning to make finer-grained distinctions (e.g., matching anger, but not disgust, with unmet goals). This ability expands between 10- and 14-months to include other discrete emotion-event pairings (e.g., disgust and novel foods). Results will be discussed in the context of (a) how emotion understanding changes over the first two years of life, and (b) how other developmental processes (e.g., motor and language development) may influence this process.

2-F-131 Preempting racial bias: Early exposure to diverse books helps children decenter whiteness

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Children's racial attitudes are well established by 6 years of age (Baron & Banaji, 2006). The present study explored the effect of diverse books on 3- to 8-year-old children's developing racial attitudes. Two

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test groups from the same population of primarily white children from homogeneous neighborhoods - with limited exposure to other children from different racial-ethnic groups - were tested: (1) 76 children in the intervention group were exposed to diverse books and conversation about race in their home for 4 months; (2) 73 children in the control group did not have this intentional exposure to diverse books. Parents completed a survey that included questions about children's exposure to diverse social groups, books, etc. Children were tested in the lab on a series of six tasks designed to examine racial attitudes in children. Across-the-board effects of diversity exposure (intervention group) were not evident. However, these children were more likely to suppress a white-first bias as indicated by random choice of creating a white or black toy character first ($p = .405$), whereas children in the control group created a white character first ($p = .074$). There was also an increase with age for coloring faces with light skin-color crayons ($p < .001$), but not dark crayons ($p < .001$). These findings highlight the importance of introducing racial diversity earlier in life and the potential value of diverse books for preempting the development of racial biases in children.

2-F-132 Effects of rules on children's lying: An investigation based on the temptation resistance paradigm

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Recent evidence suggests that children's verbal commitment to not cheat helps them to resist temptation and comply with rules. The present study investigated whether cheating can be influenced by previous exposure to rules provided by other children. Forty-eight Brazilian 6- and 8-year-olds participated in a guessing card game based on the temptation resistance paradigm (TRP). In one condition (RC), participants first watched a video with four different child actors stating rules for the game (e.g., "You have to tell the truth, and you should never lie!"). Children from the no-rule condition (NRC) watched a video of the same four children providing their assessment of the game "I liked to participate! It was great!"). Next, participants were asked to guess whether the number on each card was lower or higher than 5. At the end of the game, the experimenter left the room, creating a tempting opportunity for cheating. Results showed that 47.2% of participants cheated and 44.4% lied to cover the cheating. Moreover, an interaction between age and condition was found: no child from the 6-year-old group in the RC condition lied, in contrast to 50% of children from the same age group in the NRC condition. No significant difference was found for the 7-year-olds between the two conditions.

2-F-133 Unsafe to eat? Children's food rejection based on testimony from familiar cartoon characters and adults

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Popular cartoon characters have been widely used in educational materials to remind children to stay away from unsafe substances. However, little is known about whether these cartoon characters actually promote children's vigilance toward potentially harmful foods more than human actors. The current study investigates whether children judge the safety of unfamiliar foods based on testimony from a familiar cartoon character or an adult. Children ages 4 to 6 ($n = 75$) participated in selective trust tasks in which a familiar cartoon character and an unfamiliar adult informant provided different testimony about food safety. Children sought out information from the popular cartoon character more often than from the adult; however, they did not differentially endorse statements about food safety by either informant.

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(see Table 1). Children who had less advanced theory of mind skills and who viewed cartoon characters as more real were more likely to ask the cartoon character (see Table 2). These results suggest that when faced with questions about the safety of unfamiliar foods, 4- to 6-year-old children may be more interested in hearing from a familiar cartoon character than an unfamiliar adult, but they treat the testimony coming from these sources similarly. Their trust in characters also relates to their theory of mind and their views of the character's reality status, raising the possibility that different children will be more or less responsive to information received from a character.

2-F-134 Can chess-playing promote theory of mind? An examination of the interrelations among theory of mind, perspective-taking, and empathic concern in chess-players

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Theory of mind (ToM) is the ability to attribute mental states such as thoughts, desires, and intentions to oneself and others. ToM is important for social interactions because having an accurate representation of the mental states of others can guide social approaches. One strategy for promoting social thinking may be to engage others in chess, a two-player game that has been shown to enhance skills such as abstract reasoning, creative and strategic thinking, and pattern recognition. Chess may be a practical means of stimulating the development and empowerment of individuals with social understanding difficulties, but a first step is to examine how chess relates with theory of mind in chess players. Thus, the present study examined associations between chess-playing and theory of mind, while controlling for demographic factors and two facets of social cognition: perspective-taking and empathic concern. Participants included 233 adults, ages 18 to 70 years ($M = 26.27$, $SD = 11.73$), 54% female. Measures included a demographic survey, self-reports on frequency of chess-playing, theory of mind (ability to discern embedded false beliefs), perspective-taking, and empathic concern. A linear regression model examining age, income, chess-playing frequency, perspective-taking, and empathic concern on theory of mind, was significant. Frequency of chess-playing, perspective-taking, and empathic concern were all significant predictors of ToM. Thus, chess-playing predicted ToM, above and beyond age, income, perspective-taking, and empathic concern, indicating that individuals who play chess more often are higher in ToM. The theoretical and practical implications of these results will be discussed

2-F-135 Children's expectations for ritual performance and cooperation

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While rituals are prevalent throughout the world, we lack a comprehensive understanding of the psychological mechanisms at play when individuals engage in collective ritual behavior. In this study, we investigated whether children use information about ritual competency to decide who is a more cooperative group member. Children ($N=61$ 5-9-year-olds, anticipated $N=80$) were presented videos of adults belonging to a social group performing a conventional action sequence (shown an expert followed by a high and low competency ritual performer) then were asked to evaluate the performers to assess expectations for cooperation. Children were more likely to attribute positive behaviors ($t(60)=4.28$, $p<.001$) and less likely to attribute negative behaviors to the high competency performer ($t(60)=-2.42$, $p=.018$) compared to chance. Children were also more likely to expect the group to include high competency performers ($t(60)=3.37$, $p<.001$) and preferred high competency performers

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($t(60)=2.09$, $p=.041$) compared to chance (Fig 1). Children differed in their expectations for resource allocations in evaluating the high and low competency performers, $\chi^2(2, N=61)=12.59$, $p=.002$.

Standardized residuals show that children were more likely to expect the high competency performer to give all of their resources (1.14) and less likely to give none of their resources (-2.23). The findings from this study provide preliminary insight into whether children use ritual competency as a marker of cooperation.

2-F-136 A cross-cultural comparison on the development of social categorization and reasoning preference

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Background People hold essentialist beliefs that members belonging to certain social groups share a common underlying core that is inherently acquired, which gives rise to homogenous individual features. However, some categories are essentialized to a greater extent than others. Previous literature suggested that, long-term social contextual factors are likely to render certain aspects of social life more salient, and as a consequence, direct people's attention to particular social dimensions as more important reasoning basis. The current study seeks to explore how children and adults from U.S and China attend to different types of social categories when making social categorization and reasoning decisions. **Method** Adapted from the classic triad task, we designed eight sets of drawings depicting racially ambiguous figures. In each trial, participants saw a base figure and two target figures. Targets either share an intrinsic identity (sex/age) or an extrinsic identity (occupation/ SES) with the base. In half of the trials, participants chose one target to group with the base (Categorization). In the other half of the trials, participants chose one target that they believed to share a same novel property with the base (Induction). We manipulated the type of novel property at three levels: physical, behavioral, and social (between-subject). The current sample ($N=469$) is comprised of the following four groups: Chinese college students ($n=250$), Chinese preschoolers ($n=105$; $Mage=4.87$), American college students ($n=94$), and American preschoolers ($n=38$; $Mage=5.37$, data collection ongoing). **Results** **Categorization.** We calculated the percentage of times when participants chose the target that shares an intrinsic identity (sex or age) with the base. A 2 (culture: U.S vs. China) x 2 (age: children vs. adults) ANOVA showed no effect of culture or age differences on categorization choices. Overall, participants relied on extrinsic identities for about 72% of the time. It was unlikely for participants to use intrinsic cues in both the U.S ($M=25.5\%$) and Chinese ($M=28.7\%$) sample. **Induction.** We conducted a 2(culture: U.S vs. China) x 2 (age group: children vs. adults) x 3(property: physical, behavioral and social) ANOVA on the times participants chose intrinsic cues for inductive choices. Results showed an interaction between Culture and Property Type ($p<.001$, $\eta^2=.034$), an interaction between Culture and Age group ($p=.036$, $\eta^2=.009$), as well as a main effect of Property Type ($p<.001$, $\eta^2=.066$). U.S participants selectively favored intrinsic identity when reasoning about physical properties, but not behavioral or social properties. However, this selective reasoning pattern was not observed in the Chinese sample. Across age groups, Chinese participants showed a robust preference on extrinsic identities (occupation/ SES) over intrinsic identities (sex/ age), regardless of the task goals. **Conclusions** Social categorization serves as a fundamental cognitive process to structure our knowledge about the social world. Different social categories are weighted differently when people make categorization and inductive reasoning choices. Preliminary results indicated that, overall, occupation and SES cues were weighted importantly in both tasks, thus

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contain rich inductive potential. Growing up in a collectivistic society, Chinese participants were more likely to rely on socially loaded categories such as occupation and SES.

2-F-137 Parental messages and children's evaluations of interracial and same-race peer exclusion

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Parents convey messages to children about who they should associate with, but little is known about how children interpret these messages. The present study investigated how direct and indirect parental messages regarding other children bear on children's evaluations of exclusion. Black and White 9- to 14-year-olds ($N = 243$) read vignettes about targets deciding whether or not to include a peer in a social activity. In the direct vignette, targets were aware that parents preferred not to invite the peer. In the indirect vignette, targets received conflicting positive and negative statements about a peer without explicit directions to exclude. The encounters occurred between interracial (White- or Black-Excluder) or same-race peers, who were gender-matched to the participant. Participants then evaluated the acceptability of excluding the peer on a 6-point scale. Overall, children found exclusion more acceptable in the direct ($M = 3.46$) than in the indirect ($M = 3.12$) context, $F(1, 231) = 14.89$, $p < .001$. There was also an interaction among participant race, type of influence, and whether exclusion was between same-race or interracial peers, $F(2, 231) = 4.53$, $p = .01$. Under direct sources of influence, Black children evaluated the White-Excluder version ($M = 2.73$) more negatively than the Black-Excluder ($M = 3.39$) or same-race versions ($M = 3.61$) and more negatively than White children ($M = 3.61$; $ps < .05$). Direct messages were related to children's willingness to support exclusion more so than were indirect messages; the racial context was also significant for Black children.

2-F-138 Investigating the majority-biased imitation in Chinese preschool children

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Children are selective imitators, and research has shown that they prefer to copy the majority (Haun et al., 2013). For theoretical reasons, we were interested in testing whether Chinese children ($N = 110$, $M = 57.64$ months, $SD = 3.70$ months), as an example of Eastern culture, also engage in majority-biased copying. In four experimental groups, children saw the majority or the minority models using either inefficient or efficient approaches to achieve the goal. A fifth group served as a baseline control. One-way ANOVA showed a significant effect of testing condition, $F(4, 105) = 56.23$, $p < .001$, suggesting that children didn't increase their imitation of the causally inefficient actions with the increase in the number of demonstrators. Children integrate both efficient and inefficient acts, reflecting their motivation to build social relationships with adults who use different methods. Cross-cultural differences and universals will be discussed.

2-F-139 Four-year-olds' understanding of teaching

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Previous research in cognitive developmental psychology has examined the significance of pedagogy by studying children as the beneficiaries of teaching. However, little is known about children's understanding of teaching. In two consecutive experiments, 4-year-olds ($N = 30$ in each experiment) first learned several facts about animals (learning phase) before being asked to teach others about these animals (teaching phase). Facts children learned were of two types, episodic ("These flamingoes are standing on one leg") and generic ("Flamingoes are pink because they eat so much shrimp"). In both experiments, children predominantly taught generic, as opposed to episodic, facts. The findings support the view that by age 4, children have a sense of what it means to be a teacher, namely to transmit generic knowledge. The importance of this finding for cultural evolutionary theory will be discussed.

2-F-140 Not all families feel "fantastic" - a preschool perspective

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When children are asked to define families, the most prominent answers from initial research considered affect - such as love and caring (Anyan & Pryor, 2002). However, past research also suggests that not all families are treated the same. Farr et al. (2018), shows that children consistently rate same-sex headed families lower than other-sex headed families. Further, children develop and verbalize clear racial lines around 4 years, with the ability to explicitly separate Black and White individuals (Lieberman et al, 2017). Thus, our research seeks to identify if children rate diverse families differentially. As of 2015, over 10% of married couples were interracial (U.S. Census Bureau, 2015). Therefore, the results from this study will impact a multitude of families across the United States. Twenty-two preschool-aged children provided Likert ratings of their feelings toward vignettes of racially and structurally diverse families. In an initial analysis based on a subset of children, the results suggest that particular family types are indeed consistently rated significantly lower than an other-sex headed, White family. Compared to the control, children felt significantly less positive about interracial and same-sex headed families. Ratings toward Black grandparent led families were also significantly lower ($p < .05$). These results suggest that while children may value love and caring as important to families, perceptual cues may impact affect toward specific family types.

2-F-141 Was that intentional? Infants use emotional communication to infer and re-enact others' intended actions

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Infants are able to re-enact others' goals in their second year. However, the role of emotion in understanding others' intentions and how this ability develops remains unstudied. In this study, forty 18- and 15-month-old infants observed an experimenter attempt but fail to perform a target action on five separate stimuli (e.g., attempting but failing to pull a dumbbell apart). Infants were randomly assigned to view the experimenter express frustration or remain neutral after each attempt. Infants' re-enactment of target actions (e.g., pulling apart the dumbbell) and latency to imitate were coded. Older infants re-enacted significantly more target actions in the frustrated condition ($M = 0.67$) than the neutral condition ($M = 0.41$), $t(94) = 2.23$, $p = .03$. However, younger infants re-enacted a similar number of target actions in the frustrated ($M = 0.47$) and neutral conditions ($M = 0.41$), $t(91) = .39$, $p = .70$. Lastly, older infants initiated target actions equally in the frustration condition ($M = 4.64$ s) and neutral condition (5.75 s), $t(45) = -1.02$, $p = .32$, whereas younger infants took significantly more time to

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produce the target actions in the frustration condition ($M = 7.01$ s) than the neutral condition ($M = 3.58$ s), $t(79) = 2.64$, $p < .01$, suggesting that the ability to use emotional communication to disambiguate and re-enact others' intended actions develops during the second year of life. Implications for the role of emotion in understanding intentions will be discussed.

G – Cognition in diverse environments

2-G-139 Conversations about STEM in unexpected places: Science at a living history museum

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Opportunities for informal science learning occur in unexpected places. In this study, we explored children's science learning at a living history museum by examining the interactions of 40 caregiver-educator-child triads ($R=4;22-8;0, M=5.98$, 20 males). These settings are especially interesting as they allow the opportunity to examine children's spontaneous unstructured learning about science. Children were exposed to a variety of scientific disciplines at the history museum, including biology, physics, and engineering. Using a preregistered series of GEEs, we further examined potential learning opportunities about science. The nature of their discussions changed with age and topic. For example, children's engineering and physics talk increased with age ($ps < .002$), while their biology talk did not ($p > .770$). Caregivers and educators provided different learning opportunities for children ($p = .001$). For example, when describing a scientific phenomena, educators spent more time providing causal information than caregivers ($p < .001$). We found no significant differences in science talk produced by male and female children, nor in how caregivers and educators spoke to them ($ps > .130$). In light of work showing gender disparities in STEM learning, this finding suggests that history museums may provide opportunities to learn about science unencumbered by gender stereotypes (e.g., Crowley et al., 2001). Together, our findings contribute to our knowledge of children's STEM learning.

2-G-140 Judgments about fact and fiction by secular and Christian children in China

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Previous literature showed that children with religious exposure are more likely to judge religious and magical events as real (Corriveau et al., 2015; Davoodi et al., 2016). The current study explored children's judgment about what is real as opposed to fictional in a secular majority country - China. 62 5- to 7-year-old and 41 9- to 11-year-old children from secular and religious families were presented with stories involving realistic, religious-God, religious-Buddha, magical, and unusual mechanisms. A mixed binomial logistic model on children's reality judgments yielded a significant three-way interaction between age group, religious affiliation and story type (see Figure 1). Further analyses by story type showed that older children are more likely to judge realistic stories as real than younger children, $p < .01$; compared to secular children, Christian children across age groups are more likely to judge both type of religious stories as real, and unusual stories as fictional, $ps < .01$. Lastly, there was no effect of age or religious background for magical stories. All children judged magical stories as fictional. These findings show that as compared to Chinese secular children, Chinese Christian children in both early and late childhood are more likely to judge religious stories as real. However, the two groups made similar

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judgment about magical stories, departing from previous findings in cultures where religious believers form the cultural majority. The findings will be discussed in relation to the minority status of Christian children in China.

2-G-141 Healthy or junky? The development of classifying foods by its health status in Egypt

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While there is a growing body of research that examines children's categorization of foods in Western, educated, industrialized, rich and democratic (WEIRD) nations, we do not know if this can be applied universally. This research investigates the development of classifying foods based on its health status in an Egyptian sample. Egypt is distinctive in many respects as it is a paternalistic society and one of the most population dense countries in the world. In addition, Egypt recently has had a drastic increase in imported processed foods, though agriculture remains a main source of food. Seventy-one Egyptian 4- and 7-year-olds and adults viewed 56 pictures of foods and asked if it was healthy or junky. Participants were also asked for explanations on a subset of their responses. A 2 (health status) x 3 (age) ANOVA revealed a health x age interaction, $F(2, 68) = 3.81, p = .02$. Follow up analyses revealed that adults were more accurate in classifying foods than the younger age groups and 7-year-olds were more accurate than 4-year-olds, $ps \leq .04$. In addition, within each age group more accurate responses were provided for healthy, as compared to unhealthy, foods. Adults referred more often to the food's nutritional properties when explaining their answers as compared to the younger age groups. Overall the developmental trend in both classifying and explaining foods' health status is similar to that of Western countries, though the differences in accuracy for healthy and unhealthy foods should be further explored.

2-G-142 A head start in science: Parent-child interactions and children's science process skills

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There is an acute need to support early STEM engagement for underrepresented families, as previous work has shown that children in Head Start tend to score lower in science and math readiness compared to their higher SES peers (Brenneman, 2014). One way to broaden participation, interest, and success in STEM fields is through early intervention; delivered within successful community partnerships between informal learning settings (like science museums) and local Head Starts. In this project, a sample of 24 Head Start parent-child groups were videotaped as they played with measurement tools and blocks that varied in size, weight, color, sound, and magnetism at the museum. Preliminary results show families' that talked more about math also used measurement tools more frequently and reported more play at home with math and construction toys ($rs > .37, ps < .05$). The relation between parent-child interactions at the museum and school readiness scores will be explored.

2-G-143 Feeling of competence affects children's curiosity and creativity

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Curiosity and creativity are key elements in understanding children's learning. Children are more curious when they saw confounded evidence of a toy (Schulz & Bonawitz, 2007), and less curious if an adult demonstrated one of the functions of a toy in the pedagogical context (Bonawitz, Shafto, Gweon, Goodman, Spelke, & Schulz, 2011). Previous research on creativity has shown that children's creativity is correlated with the quality of their pretend play (Hoffmann & Russ, 2012). Here we test the hypothesis that children's psychological states influence their curiosity and creativity. Would children who feel more competent be more curious and creative? In an experiment, children completed math problems of varying difficulty, and evaluated their own performance. Children who thought they did very well on the math problems were in the high competence (HC) condition, and children who thought they did not do well were in the low competence (LC) condition. Then, children completed three tasks in counterbalanced order. In the curiosity task, they played with a novel toy similar to the one in Bonawitz et al. (2011). In the creative problem-solving task (Sylvia, Bruner, & Genova, 1976), children came up with the solution to use sticks and clips to retrieve a prize that is beyond their reach. A hint was given every minute if the child did not make progress. The third task was the Wallach and Kogan (1965) adaptation of Guilford's Alternative Uses Task. Children were asked to come up with different ways of using common objects. We tested 22 children in the HC condition and 25 children in the LC condition. The results showed an effect of testing location on the dependent variables. Since we did not predict an effect of testing location in our hypothesis, we decided to use Mixed-Effects ANOVA with testing location as a Random Effect in our analysis. In the curiosity task, there was an effect of condition on toy exploration time. It was estimated that children in the HC condition explored the toy for 62.22 seconds ($SE = 28.83$) longer than children in the LC condition ($p = 0.037$). The effect of condition on the number of unique actions performed on the toy was marginally significant: children in the HC condition performed 2.29 ($SE = 1.27$) more actions on the toy ($p = 0.078$). The number of functions that children discovered did not differ between conditions. In the creative problem-solving task, there was an effect of condition on the number of hints that children needed to solve the problem: children in the LC condition needed 1.06 ($SE = 0.52$) more hints than children in the HC condition, $p = 0.048$. The effect of condition on problem-solving time was marginally significant: children in the LC condition needed 55.46 seconds ($SE = 32.18$) longer than children in the HC condition, $p = 0.092$. Moreover, a larger proportion of children came up with the solution without any hint in the HC condition than in the LC condition ($MHC = 0.73$, $MLC = 0.36$, $t(44.85) = -2.66$, $p = 0.005$). A Mixed-Effects Generalized Linear Model confirmed that children in the HC condition were more likely to come up with the solution without any hint than children in the LC condition. In the alternative uses task, children's performance did not differ between conditions. In conclusion, children who felt more competent explored more on a novel toy and they were more likely to come up with the solution to a problem that requires creativity.

2-G-144 Mindset and approach to science: Preference for mastery goals relates to how parents talk to children about science

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Some parents favor goals of mastery, such as encouraging their children to seek out challenges, while others favor goals of performance, such as encouraging achievement. Past research demonstrates that parents who emphasize mastery over performance provide praise focused on the process rather than the person (Pomerantz & Kempner, 2013). Here, we examined whether preference for mastery relates to how parents address children's questions about science. Parents ($N = 146$) of 7- to 10-year-olds were

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asked to endorse how much they value attributes related to performance and mastery goals (Pomerantz & Kempner, 2013) and complete a measure of authoritarianism, as well as the Prompted Explanation Task (PET). For the PET, parents were prompted to answer 8 questions about science as if responding to their child. Features of the explanations, including accuracy and connections to experience, were coded. Parents who more strongly endorsed mastery goals over performance goals showed lower levels of authoritarianism, $r = .51$, $p < .001$. After controlling for authoritarianism, parents who focused more on mastery goals provided a greater number of accurate explanations and bridges to the child's other knowledge and experiences in the PET, $r_s > .26$, $p_s < .03$. This suggests that parents who value mastery goals structure their science explanations to encourage deeper and more accurate learning.

2-G-145 Can haptic feedback improve STEM learning for young children?

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Mobile media is one particularly exciting platform with the potential to teach science, technology, engineering, and math (STEM) to young children. The emerging technology of haptic feedback touch-screen displays might support hands-on learning even more. The purpose of this project is to evaluate whether preschoolers playing a STEM application (app) designed to explore the concepts of weight and balance learn better from this experience when it is presented with haptic feedback v. the traditional medium. Participants (current $N = 48$) in this ongoing study are three- to four-and-a-half (M_{age} = 3.68, $SD = .46$) and randomly assigned to one of three conditions to determine haptics' effect on learning outcomes. All participants complete assessment measures in vocabulary, comprehension, transfer, and appeal before and after playing with an app for ~10 minutes. About half played the target app enhanced with the haptic feedback ($n = 19$) while fewer played the target game without haptic feedback ($n = 17$), and the rest ($n = 12$) played an unrelated puzzle game on the tablet. Preliminary results suggest that there are no significant differences in comprehension ($F(2,43) = 0.48$, $p = 0.62$) and transfer ($F(2,45) = 0.14$, $p = 0.87$) scores by condition. Overall, these findings demonstrate that that haptic feedback does not better support STEM learning than the traditional medium. Further research is needed to determine exactly what elements of the haptic experience could enhance learning.

2-G-146 Enhanced family conversation while reading other books after eBook-reading with a conversational agent

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Previous research shows that parents typically do not use shared book-reading to actively engage children in conversation. We incorporated a helpful character into an eBook. On every page, after the story narration, he modeled open-ended questions. In the current research, 46 parents and 3- to 4-year-old children were used either the eBook with helpful character; the same eBook without character; or chose each day which version to use at home for 2 weeks. When the families returned to the lab, they read a different eBook together. Their conversations while reading were transcribed and analyzed. In Tukey t-tests, parents had significantly more utterances in the experimental ($p = .002$) and choice conditions ($p = .018$), uttered more total words (experimental, $p < .001$; choice, $p = .036$) and more unique words (experimental, $p = .001$; choice, $p = .023$) compared to control condition. Children's utterance/word count differences were similar.

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2-G-147 Pretend play in at-risk populations: The role of parents and implications for cognitive development

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Recent research has identified pretend play as a cost-effective way to support children's cognitive development in early childhood (e.g., Thibodeau et al., 2016; White et al., 2016). However, little is known about the development of pretense among at-risk children (Berk & Meyers, 2013), a population that often displays cognitive deficits (Blair, 2016). In the present study, we examined if level of cumulative risk (including income, race, education, and marital status) was related to preschoolers' propensity towards pretend play among a diverse sample of children (N=280; m age =5.4 years). Risk and pretense were negatively correlated such that children from high-risk families displayed lower propensities towards pretense ($r=-0.12$, $p\leq .05$). Further analyses indicated this relationship was mediated by parental encouragement of pretense, such that parents from higher risk families encouraged pretense less often ($\beta=-0.11$, $p<.05$). Given the previously established relationship between pretense and cognition, the lower levels of pretense among at-risk children found in the present study may partially explain the cognitive deficits commonly observed in at-risk samples. This is the first study, to our knowledge, to demonstrate less pretense in a high risk sample and highlights a need for future research on pretense and cognition, including the development and analysis of pretense interventions in at-risk populations.

2-G-148 The influence of iconicity on children's analogical problem solving from screen media

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Perceptual similarity plays an important role in children's ability to generalize learned information from one context to another (Barnett & Ceci, 2002, Gentner & Toupin, 1986). Although animation is commonly used in educational media, a lack of iconicity (i.e. resemblance to real-life stimuli) could hinder children's generalization of information from educational media to the real-world. To examine the influence of iconicity on children's learning from video, preschool children (3-5 years) are randomly assigned to a live-action or animated version of a video demonstration. The animated video uses the same audio track as the live-action video, and it depicts the same actions (see Figure 1 for sample stimuli). After watching the video, children are asked to perform an analogical problem-solving task (Figure 2). Preliminary data based on 40% of the target sample (N = 21) show that more children in live-action (vs. animated) condition transferred the problem solution from the video (56% VS 29% respectively). Data collection is ongoing. Inferential analyses comparing the conditions to each other and to chance (25%) will be conducted when we reach the target sample size based on power analysis (N = 52).

2-G-149 Variations in parental social capital and its influence on children's expectations and achievement between two immigrant groups

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The fastest-growing segment of American youth is the children of immigrants, 80% of whom are Hispanics or Asians. By 2055, Asian and Hispanic immigrants are projected to become the largest two immigrant groups in the US. Educational research on academic achievement has observed that this two immigrant groups demonstrated completely disparate academic profiles, which Asian students appear to show much higher educational attainment than either foreign- or US-born students, whereas Hispanic students tend to lag behind other groups. Explanations for the achievement gap between immigrant groups have adopted the cultural capital model and underscore the role of parents' education and expectations in children's achievement expectations and outcomes. However, much remains unclear about their influence on children's educational expectation and achievement among Asian and Hispanic immigrant groups. Our study, therefore, examined how do parents' education and expectations associate with children's expectations and achievement in this two immigrant groups. The overarching question that guides this research is when controlling for children's gender, prior achievement (i.e., 9th grade), what is the picture that emerges about the influence of parents' educational attainment and expectations on children's expectations and later achievement (i.e., 11th grade) across the two immigrant groups. To answer this question, we measured parents' educational attainment (i.e., parents' highest educational degree obtained), parents' expectations (i.e., how far parents think their children will achieve in education), children's expectations and their achievement in math for 9th and 11th grade. Using these data, we tested our hypothesized model that parents' educational attainment and expectations directly and indirectly associated with children's 11th-grade math achievement via children's expectations for Asian and Hispanic immigrant groups, controlling for children's gender and prior achievement (i.e., 9th grade). The study utilized the High School Longitudinal Study of 2009 (HSL:09) dataset. Complete data included two waves of data collection for a total of 1,523 students with at least one foreign-born parent (Asian: N = 691, 50.9% male; Hispanic: N = 832, 49.2% male). For the analysis, we first conducted an analysis of covariance (ANCOVA) to examine whether parents' educational attainment, educational expectations, children's expectations and 11th grade math achievement differ between Asian and Hispanic immigrant groups, when controlling for children's gender and 9th grade math achievement. Next, we conducted a multi-group path analysis using structural equation modeling (SEM) with Amos to examine the variations in the structural paths between the two groups. The results indicated that controlling for children's gender and 9th-grade math achievement, Asian immigrant parents had a significant higher educational attainment, yet slightly lower educational expectations than Hispanic parents. Asian immigrant children showed significant higher educational expectations and 11th-grade math achievement than Hispanic immigrant children. Multi-group analysis indicated that for both groups parents' educational attainment and expectations directly and indirectly associated with children's 11th-grade math achievement via children's expectation. The indirect effect of parents' expectation on achievement through children's expectations is stronger for Asian immigrants.

Session 3

A – Perception, action, attention and cognitive control

3-A-1 The influence of familiar characters on children's object preferences

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Product marketing often includes popular cartoon characters specifically to sway children's preferences. This strategy is so effective, children prefer damaged objects with characters on them over the same object--undamaged, but sans the character (Danovitch & Mills, 2014; 2017). This study investigated whether children's choice in this situation related to inhibitory control, and whether children would change their object choice if forced to directly consider object functionality. Across six trials, 3-4-year-olds (N=84) chose their preference for a damaged object bearing a familiar character or an undamaged, plain version of the same object (pref. trials). A toy bucket was always used on trial six. Next, children were asked to move several items across the room, using one of the two buckets from the last trial (utility trials). Results showed children preferred damaged objects with characters over plain, undamaged objects 53% of the time ($p=.042$). On utility trials, children picked the damaged objects with the character over the undamaged object only 33% of the time ($p<.001$). This suggests children value the objects' utility over the character's presence in some contexts. Children's choices on both preference and utility trials were not related to performance on the Day/Night task, suggesting inhibitory control was not related to their decisions. Thus, children may make deliberate choices based on the subjective value they place on objects' specific qualities.

3-A-2 Does bilingualism alter attentional shifting in the infant brain?

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Bilingualism is associated with changes in brain structure and function. Some suggest bilingualism also improves cognitive control mechanisms, as early as 6-months. In particular, bilinguals engage the brain's left frontal "language" regions during non-verbal cognitive control tasks, whereas monolinguals engage right frontal regions (Arredondo et al., 2017). Little is known about the developmental course of these brain differences and whether they are evident in infants. Using functional near-infrared spectroscopy, we measured brain activity in monolingual- and bilingual-learning 6-month-old infants (N=60) during the non-linguistic Infant Orienting with Attention task. Preliminary results reveal bilingual-raised infants activate left frontal "language" regions to a greater extent than monolingual-raised infants (see Figure). The findings will be discussed in relation to infants' daily amount of dual-language experiences. Taken together, these results begin to indicate how the brain supports dual-language acquisition and how language experience can alter the neural organization underlying broader, non-linguistic cognitive functions.

3-A-3 Infants incorporate a skeletal model of shape for object recognition

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It is well known that shape information is crucial for object recognition. Yet the computations involved in forming representations of shape remain poorly understood. Studies with adults and computer vision systems suggest that human vision represents and compares shape using a skeletal model (Kimia, 2003), which describe the metric relations between an object's contours and component parts (Fig. 1A). The strength of such a model is that it provides both a compact descriptor of shape and supports quantitative comparisons between shapes. Importantly, skeletal models have been found to predict adults' similarity and categorization judgments, outperforming other models of object recognition including state-of-the-art convolutional neural networks (Ayzenberg & Lourenco, 2019). Here we tested whether object recognition is accomplished vis-à-vis a skeletal computation of shape from early in

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development when object experience is limited. Although research with newborn chicks suggests that object recognition is experience independent (Wood, 2013) and human infants are sensitive to the spatial structure of object parts (Kraebel & Gerhardstein, 2006), it remains unknown how infants represent shape for object recognition. Indeed, infants and chicks could have relied on other visual properties, such as image-level similarity (Tarr, 1995) or the categorical spatial arrangement of diagnostic component parts (Biederman, 1987), rather than a shape skeleton. To test whether infants rely on a computation of the shape skeleton for object recognition, we created objects with different skeletons, each rendered with one of two surface forms serving to change both the image-level and component-part properties of the object without changing the underlying skeleton (Fig. 1B-C). An independent experiment confirmed that surface forms were matched for discriminability with the skeletons and were comprised of unique component parts. Seventy infants (Mage = 9.5 months, range = 6.1 - 11.8 months) were tested across two experiments. In Experiment 1, infants were habituated to one rotating object and then presented with two objects, one with a familiar skeleton and one with a novel skeleton (alternating trials). Familiar and novel test objects differed in surface form from the habituated object (Fig. 1B). We found that infants looked significantly longer at the object with the novel skeleton than the object with the familiar skeleton, $t(28) = 2.45$, $p < .05$, $d = 0.46$ (no age effect), suggesting that object recognition was based on a skeletal representation robust to surface form changes. In Experiment 2, we provided an even stronger test of skeletal sensitivity by testing whether infants could recognize an object by its skeleton when the test objects had the same categorical spatial arrangement of component parts and exhibited a high-degree of image-level similarity (Fig. 1C). We found that, again, infants looked significantly longer at the object with the novel than familiar skeleton, $t(40) = 2.33$, $p < .05$, $d = 0.36$. Taken together, the results from these experiments provide the first demonstration of object recognition via a skeletal computation within the first year of life, akin to what has been found in human adults. That infants recognize objects by their skeletons prior to extensive object experience suggests that skeletal models may serve as a perceptual mechanism to support object learning.

3-A-4 Children's production of typical face configuration: Large errors and no effects of inversion

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Adult observers are sensitive to the configuration of facial features within a face, able to distinguish between relative differences in feature spacing, and detecting deviations from typical facial appearance. Children's sensitivity to the same aspects of facial appearance develops during middle childhood (Mondloch et al., 2004). While children are generally quite good at distinguishing between faces based on the local shape of face parts or changes to the external contour of the face, their ability to detect metric changes to face geometry is more limited, only reaching maturity at some point after age 8. However, while their ability to distinguish between faces based on small configuration changes continues to develop, both children and adults tend to be sensitive to deviations from typical face configuration. For example, 3- and 7-year-old children make ordinal attractiveness judgments in response to typical and distorted face configurations that are consistent with adults' evaluations of typical face appearance (Short et al., 2015) and express preferences for facial features placed in a typical position within an external contour over those placed in a higher position (Cooper et al., 2006). While distinguishing between a typical and atypical face configuration tends to be achievable by adults and children, estimating typical face configuration is a good bit more difficult for adults. In portraiture, many

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adults suffer from the "squashed skull effect" in which facial features are placed too high within the external contour of the face (Edwards, 1979) and in laboratory studies, adult participants struggle to re-create the facial configuration of familiar celebrity faces (Balas & Sinha, 2008). We argue that production tasks like these offer an important complement to discrimination and preference-based studies. Specifically, they do not require an a priori choice of what aspects of face configuration to manipulate, nor do they require calibration with regard to the magnitude of deviations from typical appearance. Finally, we suggest that the perception and production of typical face appearance may depend on distinct mechanisms. Presently, we thus chose to investigate children's productive estimates of typical face configuration by comparing face "portraits" created by children and adults. In the current study, we implemented a production task in which adults and children between the ages of 5 and 10 years old created a face "portrait" by arranging the eyes, nose, and mouth of a standard face within an empty outline that could either be presented upright or inverted. We found substantial differences in face configuration across age groups, such that children of all ages made far larger errors than adult participants, particularly with regard to the vertical position of the eyes and nose within the face outline. Moreover, we found that across all age groups, configuration was not affected by inversion, in contrast to the large effects of inversion on face perception. We discuss these results in terms of the development of sensitivity to typical face appearance, and the relationship between production paradigms and purely perceptual tasks.

3-A-5 Reevaluating the bilingual advantage using a new developmental task

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A key current research focus in childhood bilingualism is the "bilingual advantage" in executive function (EF) tasks (i.e., attention shifting, memory, inhibition), attributed to bilinguals constant need to control their two languages via inhibition and shifting. However, the explanations for, the magnitude of, and even the existence of a bilingual EF advantage are highly debated (De Bruin, Treccani & Della Sala, 2015). Some attribute bilinguals' differential performance to methodological issues (small samples, demographics, etc.) and/or to a confirmation bias (Paap & Greenberg, 2013). We used a short, engaging task to look at children's EF: a game consisting of 20 trials where children choose one of five objects that does NOT match what is on a displayed card, based on two dimensions (object/color). Thus, the task involves attention shifting and inhibition, key processes underlying the possible bilingual EF advantage. We recruited children ages 4 to 8 in a museum-based setting in a bilingual region (N = 28). We confirmed a developmental shift in task performance. Age positively correlated with the number of correct object selections ($r = .58$, $p < .01$). Partialling out age, we found no relationship ($r = .01$, $p = .96$) between performance in our EF task and children's position on the bilingualism spectrum based on parental report (from 0 = equal daily use of languages to 1 = daily use of only one language). For future directions, we will expand our sample of 4- to 6-year-olds, as children reach ceiling performance by 7 and will also recruit more pure monolinguals to further explore if a group difference is present.

3-A-6 Probing the effects of response type in a visual working memory task

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Visual working memory (VWM) allows us to hold visual information in mind to be manipulated for a task. Previous research shows that performance varies based on factors such as stimulus modality and

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number of distractors. This study aims to explore the effects of response type on VWM performance in 4.5- and 5.5-year-olds. A single-probe color change detection (CD) and a cued recall (CR) with labeling task (Figure 1A) were administered. Neural data were collected using functional near-infrared spectroscopy (Figure 1B). Both tasks used set-sizes 1-3. All children performed the change detection task first. Preliminary analyses show that children's performance declined as set-size increased, more so in the CR task. Both tasks activated bilateral temporal and parietal cortices. The CD task also elicited activation in bilateral frontal cortex. Though both tasks required the same WM processes, distinct neural regions were involved based on the response type.

3-A-7 Baseline and task-related EEG coherence is linked to nonperservative and perservative errors on the Wisconsin card sorting task

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The Wisconsin card sorting task (WCST) measures frontal cortical functioning; this examines complex cognitive functioning, such as conceptual shifting, working memory, and abstract reasoning. Based on previous adult research, frontal EEG power and coherence in EEG bands ranging from 8 - 27 Hz during baseline and task are indicative of performance on the WCST, (Carrillo-de-la-Peña & García-Larrea, 2007; Çiçek & Nalçac, 2001). Therefore, in the present study, we analyzed baseline and task-related frontal EEG coherence in three different alpha bands in 9 - 10-year-old children, alpha (6 - 9 Hz), low-alpha (8 - 10 Hz), and high-alpha (11 - 13 Hz). Baseline coherence was correlated with greater preservative errors, whereas task-related EEG coherence was correlated with nonperservative errors. Baseline connectivity provides insight into the inability to shift rules, whereas task-related connectivity is informing on random errors. Our results indicate that examining both baseline and task-related EEG coherence can be advantageous in differentiating between WCST errors.

3-A-8 The classroom visual environment: Source of distraction or opportunity for incidental learning?

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Maintaining attention during instruction is challenging for young children (Godwin et al., 2016; Karweit & Slavin, 1981). The typical classroom contains numerous distractions (e.g., peers, announcements, noise) including attentional competition from the classroom visual environment itself. Recent research suggests that the classroom visual environment is a source of distraction that increases children's off-task behavior and decreases learning (Fisher et al., 2014; Hanley et al., 2017). In light of such evidence, educators may opt to streamline the classroom visual environment. However, many classroom displays are not educationally relevant (Almeda et al., 2014), which raises the possibility that the detrimental effects of highly decorated visual environments may be offset by closely aligning the displays to the instructional content. Alignment of the visual environment could serve to reinforce or incidentally teach lesson content. The present study investigates this possibility. Thirty-two elementary school students (Mage = 8.51 years, SD = 1.97) watched a science lesson on a laptop computer while trifold boards were used to manipulate the alignment of the visual environment to the lesson. The visual environment was manipulated between-subjects and participants were randomly assigned to either the: (1) Streamlined condition consisting of a plain trifold, (2) General condition in which the trifold contained educational displays unrelated to the lesson, or (3) Relevant condition where the trifold contained displays that

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reinforced the lesson content and presented content topically related to the lesson. The lesson content was novel; pre-test scores ($M=.23$, $SD=.12$) were not significantly different from chance ($.25$; $t(31)=-1.02$, $p=.32$) and there was no effect of condition ($F(2,29)=.75$, $p=.48$). Attention to the lesson was measured using eye tracking technology. Fixation duration was recorded and the proportion of time participants fixated on the lesson was calculated. A post-test was administered to assess learning. The post-test included 3 question types: (1) questions probing content presented in the lesson, (2) on the trifold, or (3) content that was presented in both the lesson and on the trifold. Gain scores were calculated. Data collection is in progress. Preliminary results of a 3(Condition) x 3(Question type) mixed ANOVA indicate a marginally significant effect of Condition ($F(2,28)=2.75$, $p=.08$, partial $\eta^2=.16$) and a significant effect of Question type ($F(2,56)=3.17$, $p=.05$, partial $\eta^2=.10$) on Gain Scores. Pairwise comparisons, revealed that Gain Scores in the Relevant ($M=.29$) and Streamlined ($M=.14$) conditions were not significantly different ($p=.32$). This was true across all question types ($ps\geq.12$). However, Gain Scores were larger in the Relevant condition compared to the General condition ($M=.09$; $p=.10$). This pattern of results was found across two question types - for lesson questions ($MGain = .36$ vs $.10$, $p=.02$) and questions pertaining to content presented in both the lesson and trifolds ($MGain = .25$ vs 0.00 , $p=.084$). The proportion of time fixating on the lesson ranged from $.38$ to $.45$ across conditions; however, there was no effect of condition ($p>.05$). Taken together, these results tentatively suggest decorated visual environments need not always be detrimental to learning. By aligning the visual environment to the lesson content educators may be able to help bolster children's learning.

3-A-9 Observing others when the end-goal is not immediately visible: eye-tracking, convolutional neural networks, and EEG

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By observing others, children come to understand behavior in functional terms because they acquire conceptual information about action goals. However, little is known about how children perceive other people's actions when the end-goal is not immediately visible in the scene. We combined remote eye-tracking, convolutional neural networks (CNN), and EEG to examine how preschoolers ($N = 24$) and adults ($N = 24$) perceive actions as they observed video clips of adults using two different ways to grasp a hammer to subsequently pound a peg. One way to grasp the hammer is more efficient to accomplish the end goal than the other way. Both groups equally fixated on task-relevant areas of the scene. However, CNN analysis revealed that looking patterns differed between groups: Preschoolers, unlike adults, did not gather sufficient visual information about the type of action in the absence of an immediate goal. At the neural level, adults exhibited differences in action-related neural activity when they observed the different grasping actions, whereas preschoolers did not. Findings reflect children's low visual and neural sensitivity to actions when the end goal stretches far into the future.

3-A-10 Effects of exceeding AAP media use recommendations on impulsivity in preschoolers

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The preschool years are crucial for the development of skills required in sustaining attention, inhibiting behaviors, and shifting attention. Deficits in sustained attention and response inhibition have been implicated in disorders such as ADHD (Wiebe, Sheffield, & Espy, 2012). As technology becomes more prominent, it is important to examine and understand the effects of media and technology on children's

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cognitive development. Lillard & colleagues (2015) found deficits in children's executive functions immediately after viewing cartoons, though further research is needed. The American Academy of Pediatrics (AAP) recommends that parents of children between 2-5 years limit media use to 1-hour of high-quality programming with parental engagement per day. The objective of this study is to describe media use habits of preschoolers and to compare impulsivity in those who meet and exceed the AAP recommendations. Preliminary analyses of 60% (n=60) of the target sample suggest that 51.7% of preschoolers (n=31) meet the AAP recommendations for duration (M=260 minutes per week). There are significant correlations between minutes of media use per week and false alarms ($r=.269$, $p=.038$); false alarms and reaction time ($r=-.459$, $p<.01$); and minutes of media use and reaction time ($r=-.359$, $p=.005$) in a 3-minute iPad-based Go/No-Go task. These findings suggest that as children engage with more media, they are more likely to respond faster and more impulsively, thus making more errors.

3-A-11 Visual rule learning: The connection between human action and speech

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A critical ability for language acquisition is detecting and generalizing rule-governed patterns. Infants succeed in generalizing rules involving repetitions in speech (e.g., ABB & ABA patterns; Marcus et al., 1999), but they are more limited in non-linguistic domains (e.g., animal sounds, tones, and shapes; Marcus et al., 2007; Johnson et al., 2008), especially with non-adjacent repetitions (ABA). Infants can learn from visual information if items are presented concurrently (Saffran et al., 2007), reducing encoding and memory demands. However, spoken language is sequential, not concurrent. To explore the domain specificity of infants' sequential rule-learning, we investigated a different type of non-linguistic stimuli: visual human action (e.g., raise a leg, turn head, bow, etc.). Visual human actions are similar to speech in that both result from dynamic human action, yet they are neither auditory nor linguistic, thus providing an informative medium to better understand infants' linguistic rule learning. Fourteen 9-month-olds were habituated to human actions following ABA or ABB pattern. The test phase consisted of 8 trials with novel actions: half followed the pattern seen in habituation, and half followed an inconsistent pattern. For both habituation patterns, infants learned the rule and generalized to novel actions, looking longer to inconsistent trials ($p = .016$). Taken together, prior research, along with the present finding of successful rule learning in a non-linguistic domain suggest that dynamic information, perhaps specific to human action, facilitates encoding and rule generalization from sequential stimuli in linguistic and non-linguistic domains.

3-A-12 Object demonstration after object exploration impacts action perception in 6-month-old infants

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Previous work found unaided object exploration influenced later perception of object actions in 9- and 11-month-old, but not 7-month-old infants (Hauf, Aschersleben, & Prinz, 2007). After infants manually explored an object (caterpillar or crab toy) for 90 s, they received a 10 s live demonstration of object-related actions by an adult with the same object. It was tested whether infants' own exploration combined with observational action experience impacted their subsequent perception of object-related actions presented on video with an eye tracker. Results including 28 six-month-old infants showed an interaction between prior object experience (with the same or a different object) and object type

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(caterpillar or crab toy) for fixation frequency to the actors' hands ($p=0.004$). Infants looked more frequently to the actors' hands when manipulating the caterpillar if they had prior experience with the caterpillar. Findings suggest object features influence whether relatively naturalistic object experience facilitates perception of object actions in 6-month-old infants.

3-A-13 The role of clutter and context on the dynamics of toddler object play

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Object play provides a critical setting for early learning (West & Iverson, 2017). Although several studies have investigated the dynamics of object play, many miss key characteristics of everyday environments. Using data from the Longitudinal Study of Early Language (Naigles & Fein, 2017), we investigated how play is affected by two features characteristic of home play: object clutter (i.e., multiple objects compete for attention) and object diversity (i.e., different toys afford different dynamics). Ten parent-toddler dyads were observed in their homes at 20 and 32 months of age. Dyads were given toys (e.g., books, balloons, cups, blocks) and prompted to play with each toy one at a time. We analyzed object-specific object prompts and coded moments toddlers touched the target of the prompt and other distractor objects. Preliminary results revealed that in certain contexts (e.g., book reading), and unlike in several laboratory studies, toddlers touched distractors more than targets (56.9% vs. 12.3% at 20mos, $p<.05$; 70% vs. 6% at 32mos, $p<.001$). In others (e.g., balloon-blow-up-and-release), toddlers touched targets and distractors at similar rates, suggesting that different objects lead to different play dynamics. These data underscore the value of understanding object play under more ecologically-valid conditions (see Tamis-LeMonda et al., 2017). Ongoing analyses explore how these dynamics change with development and how they differ in toddlers with Autism Spectrum Disorder.

3-A-14 Decision-making in early childhood: Young children shift from perseverance to systematic exploration

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Recent work indicates that children seem to be highly exploratory and surprisingly systematic in their choice patterns. Few studies have examined these patterns in very young children. It is unknown whether the systematic exploratory behavior exhibited by children (i.e. 4-year-olds) is present in infants or if it emerges later on. The present study examined patterns in infant and toddler's choices among options with varying levels of appeal. On each trial, children ($n = 69$, 15-36 months) were presented with three boxes on a screen and asked to pick a box. Selecting a box caused the box to open and reveal a toy. The toys were either exciting or neutral. The younger children chose the more exciting toy significantly more often than other toys, while the older children did not express this preference. Age was correlated with how often the children switched between options: younger children tended to repeatedly select the same box while the older children consistently switched between boxes. Switching behavior also became more systematic with age: older children were more likely to choose the least recently selected option rather than switching randomly, a pattern consistent with systematic exploration. These findings suggest qualitatively distinct stages of exploration development. While very young children may be focused on immediate reward or perceptual salience, as infants emerge into childhood, they transition to a state of systematic, elevated exploration of their choices.

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3-A-15 Exploring socioeconomic status differences in executive function across development

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Socioeconomic status (SES) in childhood is associated with differences in cognition (Sirin, 2005), including executive function (EF) skills (working memory, cognitive flexibility, and inhibitory control). EFs are, in turn, related to later life outcomes such as school readiness and academic success (Zelazo, Carlson, & Faja, 2005). However, little is known about whether SES-related differences in EF change over time. Using a large, existing data set, we explored the possibility that children of lower SES backgrounds show less improvement over time, compared to children of middle and high SES backgrounds, on a widely used measure of EF, the Minnesota Executive Function Scale (Carlson & Zelazo, 2014). We selected children who were between 2 and 5 years of age ($n = 4,307$) and had completed the task 2 to 3 times, with 5-7 months between assessments. Results of a linear model predicting Time 1 - Time 2 suggested children from lower SES backgrounds improved less on the task over time, controlling for age at first testing, gender, and duration between testings. However, this relationship was not statistically significant when predicting Time 1 - Time 3 change scores. Moreover, the relationship was small and not present across all included age groups. Confirmatory longitudinal studies can replicate the findings and address potential confounds.

3-A-16 Top-down activation in mid-level visual regions supports efficient object perception in 8-10-month-old infants

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By 4 months of age, infants are capable of perceiving objects as whole units, even in the absence of complete visual evidence. This requires that knowledge of defining principles of objects, including continuity and closure, impact lower level visual processes. In adults, this top-down object knowledge is conveyed through feedback from the lateral occipital cortex (LOC) to primary visual cortex (V1). Yet, the functionality of feedback pathways has not been established in infancy. We tested 8-10 month-old infants ($N = 25$, $M = 9.6$ months, $SD = 0.84$ months) in a paired behavioral/fNIRS study. Infants were shown images where identical PacMan inducers were oriented to either support perceptual illusions of objects (Kanizsa) or not (Scrambled). Consistent with prior work, infants provided behavioral evidence of perceiving the Kanizsa illusion, $t(24) = 3.51$, $p = .002$. Moreover, fNIRS data indicated that infants had greater activation, in both LOC and V1, to Kanizsa relative to Scrambled images, $F(4,84) = 4.034$, $p = .005$. These data indicate that neural feedback pathways are functional in late infancy in support of efficient object perception.

3-A-17 What if everyone else waited?: Peer norms influence preschoolers' delay of gratification

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How do peer norms affect children's ability to delay gratification? To address this question, 53 preschoolers (37 girls; $Mage = 53.38$ months) were randomly assigned to hear differing information about peers' delay choices before completing a 10-min marshmallow task. They were told that all children who played the game before them waited for a large reward (waited condition), none of the

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children waited (did not wait condition), or some children waited and some did not (control). Preliminary results, controlling for age, indicate that peer norms do influence delay times, $F(2, 49) = 4.54$, $p = .016$. Specifically, children in the waited condition (EMM = 504.01 s, 95CI [392.54, 615.47]) delayed significantly longer than children in the control condition (EMM = 273.69 s, 95CI [165.25, 382.13]), $p = .005$. However, children in the did not wait condition (EMM = 418.65 s, 95CI [300.51, 536.79]) also delayed marginally longer than children in the control condition, $p = .075$. We found no differences between the waited and did not wait conditions, $p = .296$. These results speak to the importance of peer behavior in shaping children's choices (see also Doebel & Munakata, 2018). Importantly, however, the finding that benefits accrued in both the waited and did not wait conditions suggests that the mechanism is more complex than mere mimicry. Overall, the current study supports a growing body of research underscoring the importance of sociocultural influences on young children's self-control.

3-A-18 Understanding the development of inhibitory control through intervention: Changes in the effectiveness of in-the-moment reminders across 3-7 year-old children

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Inhibitory control over our thoughts and actions develops dramatically across childhood. These developments may reflect children transitioning from primarily engaging control reactively (in-the-moment as needed) to increasingly engaging control proactively (planning ahead to engage), given the role of proactive processes in mature inhibitory control. This transition suggests that older and younger children may benefit from different forms of inhibitory control support. To test this account, we assessed whether the effects of in-the-moment reminders varied with age across 3-7-year-olds in a Go/No-go task. Children who received in-the-moment reminders showed slower response times than children who did not receive reminders ($F(1,125)=31.15$, $\eta^2= 0.01$, $p<.001$). This effect varied by age: older children's response times were less affected by reminders than younger children's ($F(1,125)=7.59$, $\eta^2= 0.002$, $p=.006$). Reminders did not significantly affect accuracy. Reactive processes in young children may be influenced by in-the-moment reminders, but require more salient interventions to reliably improve inhibitory control.

3-A-19 Effects of threat stimulation types and individual difference on preschooler's inattentional blindness

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Detecting the threat-relevant stimuli is very important for preschoolers' safety in life, but few studies have investigated how preschoolers process unexpected threat-relevant stimuli in the way that most threat-relevant stimuli occur. The effects of the threat stimulation types on inattentional blindness were investigated in two tasks (Cross-judgment Task in Experiment 1a and Turntable Task in Experiment 1b) and the individual difference of IB in the fluid intelligence and attentional control were also inspected (Experiment 2). With the involvement of two hundred and thirty-nine preschoolers, we found that preschoolers were not more likely to detect the threat-relevant stimuli (Knife and Snake). Instead, when the unexpected stimuli occurred many times, the detection frequency of non-threat-relevant stimuli (Spoon and Snail) was higher than the threat-relevant stimuli. In addition, when the unexpected stimuli occurred only once, the 5-year-old preschoolers with higher fluid intelligence scores were more likely to

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detect the unexpected stimuli. It indicates that inattention blindness is a task-specific phenomenon and the detection of unexpected stimuli is sensitive to different factors in different tasks.

B – Memory and reasoning

3-B-20 Working memory and quality control in children's novel production of passive sentences

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Working memory (WM) is widely accepted as a necessary cognitive resource for various cognitive abilities, including language comprehension and production. We seek to add evidence to the cognitive view of language development by examining what changes occur in child language production when WM resources are constrained. We required 4- and 5-year-old children (n=36) to produce passive sentences (e.g., the flower was watered by the girl) while concurrently maintaining a verbal or visual WM load. Children heard an experimenter describe images in the passive voice, and were later asked to use the same way of speaking to describe these same pictures, sometimes while under a visual or verbal WM load. Surprisingly, children used the passive more often under a load, but made more errors in that condition (e.g., "the girl was watered by the flower"). Children chose the more familiar active voice when uncertain about use of the passive, but failed to control quality under WM load.

3-B-21 Breakfast comes after dinner?: The relation between preschoolers' temporal memory, time knowledge, and cognitive flexibility

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Temporal memory (i.e., memory for 'when'), develops more slowly than memory for 'who' and 'where' (Lee, Wendelken, Bunge, & Ghetti, 2016). Children start including temporal information in reports of personal events at the end of preschool (Reese, 2009). Friedman (1993) suggested that placing events in time requires the combination of recalled details and time knowledge (e.g., months, seasons). Cognitive flexibility (i.e., shifting between mental sets) may be associated with the ability to coordinate event details with time knowledge given that it involves switching between episodic information and semantic knowledge. We examined temporal memory of personal events, time knowledge, and cognitive flexibility in sixty-two 4- to 5-year-olds. Participants were interviewed about recent events, and we coded responses for temporal information. They also completed a time knowledge task, which assessed their cyclical understanding of meal order (e.g., lunch, dinner, breakfast). Cognitive flexibility was measured with the Dimensional Change Card Sort (DCCS; Zelazo, 2006). We ran a multiple regression with temporal information as the dependent variable, and DCCS performance, time knowledge, and its interaction as independent variables. DCCS performance was a significant predictor, $\beta=.44$, $p=.01$. The interaction was a marginal predictor, $\beta=-.30$, $p=.07$, as DCCS performance was a significant predictor of temporal information for children with less mature time knowledge, $\beta=.50$, $p<.01$. Thus, being more flexible helps children with less knowledge produce more temporal details when recalling events.

3-B-22 Neural mechanisms of memory dependent planning in 3 and 4 year olds

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Planning for future events often requires coordinating retrieval of relevant information from memory and then deployment of this information to achieve a desired goal. As the number of steps required to achieve a goal increases, 3-4-year-old children can retrieve the relevant memories, but have more difficulty deploying them correctly (Blankenship & Kibbe, 2019). The current study investigated sources of these limitations using EEG in 3-4-year-olds ($N=13$; $M=53.9m$) during a multi-step memory-based planning task. We found that, as the number of steps increased, 1) children's correct responses decreased ($p<.001$); 2) temporal theta power increased ($p<.05$), suggesting increased engagement of memory retrieval processes with task difficulty, and 3) frontal alpha power did not change ($p=.196$), suggesting planning processes did not vary with task difficulty. These data provide insights into sources of limitation on memory-based planning in early childhood, suggesting executive functions may play a more limiting role than strategic retrieval of relevant memories.

3-B-23 One- and two-year-olds act in accordance with the temporal priority principle

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Previous work has shown that 3-year-olds grasp the temporal priority principle—that causes must precede their effects. This study used a novel behavioral paradigm to investigate whether 1- and/or 2-year-olds ($N=133$) share this ability. In Experiments 1 and 2 toddlers watched an adult perform an action (A) on a puzzle-box, following which a sticker dispensed (effect E), following which the adult performed a second action (B). Toddlers then interacted with the box and manipulating A produced a sticker (they retrieved 5). One- and two-year-olds were significantly more likely to intervene on A than B when both actions were on the same box as the sticker dispenser ($\beta_{\text{intercept}}=-2.51$, $se=0.55$, $p<0.001$, Exp. 1), and also when A was disconnected from the sticker dispenser ($\beta_{\text{intercept}}=-1.57$, $se=0.29$, $p<0.001$, Exp. 2), demonstrating that temporal priority trumps spatial contiguity as a cue to causality. Experiment 3 ruled out that toddlers acted on the basis of a primacy effect in the previous experiments. Toddlers watched an adult perform A followed by B followed by effect E, so that A was still first, but while both actions were temporally prior to the effect, action B immediately preceded it. In contrast to Experiments 1 and 2, toddlers were more likely to intervene on B than A ($\beta_{\text{intercept}}=1.41$, $se=0.27$, $p<0.001$). Given a lack of any age effects in this study, these findings provide evidence that toddlers already have a grasp of temporal priority within the second year of life.

3-B-24 Learning from children: Adults' exploratory causal inferences benefit from observing child-led explorations

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Prior research has shown that adults are less likely than children to consider unconventional causal forms such as multiple causes conjunctively producing an effect (Lucas et al., 2014; Gopnik et al., 2017). Two experiments examined whether observing children's exploratory causal explorations promote adults' flexible causal learning. In Experiment 1, 72 parent-child (4-6-year-olds) dyads played with a machine and objects. Each dyad saw events that were statistically best explained by a conjunctive causal form. Next, the dyad explored new objects independently (Solo), or jointly through interactions led by the child (Child-Led) or by the parent (Parent-Led). The dyad was then asked to generate the effect using the objects. Overall, children outperformed adults in learning the conjunctive rule regardless of condition: Children were more likely than adults to explore objects jointly, $b=0.56$, $p=.021$ and use

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multiple objects to activate the machine in test, $b=1.82$, $p<.001$. Critically, whether adults led or observed influenced adults' reasoning. Adults in the Child-Led group were more likely to use multiple objects to activate the machine than those in the Parent-Led group, $b=1.44$, $p=.022$. Experiment 2 examined whether "child" evidence is sufficient to support success: 96 adults saw an adult actor perform interventions, but we yoked the evidence to the interventions attempted by either children or adults of Experiment 1. Adults who observed child-yoked interventions provided more correct conjunctive responses than those who observed adult-yoked interventions, $b=0.91$, $p=.033$. These results suggest that observing child-generated evidence supports adults' flexible causal inferences.

3-B-25 "As long as we are being nice and happy, it's going to be okay." African American and Mexican mother-child contributions to positive and negative shared memories

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Research on mother-child reminiscing has established distinct individual and cultural variations in maternal style - specifically elaboration. Past research has only studied a limited number of cultures. This study extends the research by examining the conversational interplay of 33 African American (AA) and 32 Mexican mother-child dyads during positive and negative reminiscences. Children were 6 years old at the time they were tested. Differences between the two groups of mothers emerged. AA mothers took significantly more elaboration turns and used more words than Mexican mothers; however, when assessing the ratio of elaborations to repetitions, these significant differences disappeared. Although AA mothers spoke at nearly double the rate of Mexican mothers, their children did not participate more than Mexican children. Mothers also differed in how they responded to their children's memory contributions depending on the emotional valence of the memory under discussion. Interestingly, both groups of mothers significantly spoke less and were less elaborative during negative reminiscences than positive - a distinct break from past research. Mothers dominated these shorter conversations, with children participating significantly less. Findings suggest that reminiscing has different social-cultural functioning for these two groups and thus more cross-cultural work must be done to gain a better understanding of reminiscing.

3-B-26 The role of mechanism information in infants' learning of physical causal events

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A study with 10-, 14, and 18-month-olds ($N = 67$) tested whether infants are sensitive to mechanism information in a physical causal event. Infants were habituated to an event whereby one object launched another following a perceivable fuel transfer lasting 2 seconds. Infants were then tested with a familiar event, a direct launching without transfer event, and a delayed launching event. The question of interest was whether infants would treat the transfer and direct launching event as equivalent based on the causal roles of the agent and recipient even though one involved a delay. Data collection is ongoing. A marginally significant interaction exists between age and test (B14mo launch = 5.19, $p = 0.11$; B14mo delay = 3.68, $p = 0.11$; B18mo launch = 3.90, $p = 0.11$). Ten-month-olds looked equally at all tests; 14-month-olds looked longer at direct ($M = 10.7$, $SD = 10.2$) and delayed ($M = 10.5$, $SD = 9.95$) than at transfer launching ($M = 5.83$, $SD = 4.64$). In contrast, 18-month-olds looked similarly at transfer ($M = 5.33$, $SD = 4.52$) and direct launching ($M = 7.91$, $SD = 9.03$) but longer at delayed launching ($M = 9.99$, SD

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= 10.8). Preliminary data suggest that by 18 months infants can perceive a delayed launching event to involve a causal relation if there is a plausible mechanism that underlies it.

3-B-27 The relationship between intuitive biology thinking and different levels of scientific expertise

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Cognitive psychology research has shown that intuitive thinking influences undergraduate student misunderstanding of biology topics such as climate change or evolution. In the current study, we examined whether beginning and advanced biology majors differed in terms of intuitive biological thinking. First- and final-year biology majors (N=197) were given written assessments of teleological, essentialist, and anthropic thinking. The results show clear evidence of intuitive biological thinking in both groups, and few differences between the groups. While groups did not differ on teleological measures, they did differ on some of the essentialist measures (absolute category membership and categorical homogeneity) and some of the anthropic measures (property projection, and marginally on biological similarity). These results suggest that formal education in biological science may have little impact on intuitive biological thinking, which supports the notion that even for biology students, science and intuition may coexist as alternative explanatory systems. More generally, determining how students interpret information from the classroom in light of their prior knowledge is important for future work towards minimizing scientific misconceptions.

3-B-28 Control variables, but only when it makes sense: Children adapt their testing strategies according to causal sparsity

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What is the best way of figuring out the structure of a causal system composed of multiple variables? One prominent idea is that learners should manipulate each variable in isolation to avoid confounded evidence--known as a <i>Control of Variables strategy (CVS)</i>. CVS is considered one of the pillars of scientific reasoning and is a central component of STEM curricula. Despite this, educational research has revealed that it is very difficult to teach children to consistently use this strategy. However, CVS is not always the most efficient approach to identifying causal structure. For instance, imagine trying to establish which switch on a badly labelled basement fusebox controls an upstairs bathroom light. In this setting, it is more efficient to test several switches at a time, and progressively narrow in on the right switch, so as to minimize the expected number of trips up the stairs. If all are equally likely a priori, one should turn on half the switches at first, check whether the bathroom lights turn on, then continue to test half of the remaining candidates until the right switch is found. In general, when a causal system is sparse, that is, when the outcome of interest has few or only one cause among the candidate variables, as in the fusebox example, more efficient strategies than CVS may be available. Recent work has shown that adults are sensitive to causal sparsity and adapt their testing strategies accordingly. In the present study, we investigate when this sensitivity and adaptivity emerges. Children were presented with a box with six switches connected to a lightbulb, and assigned to one of two conditions. In the Sparse condition, they were told that only one of the switches worked and could turn on the lightbulb; the best strategy was to test half the switches at once. In the Non-sparse condition, children were told that all

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the switches could turn on the lightbulb except for one, which was broken; in this condition, testing the switches one by one was the best approach. The goal of the game in either case was to identify the working/broken switch with as few tests as possible, by testing combinations of on/off switches. To promote efficient search, we introduced a search cost: children were given 6 tokens, and were asked to pay one for each combination. At the end of the session, they were rewarded with one sticker for each token they had left. We found that children were sensitive to the causal sparsity of the task: in the Sparse condition, a higher proportion of children approached the task by turning on multiple switches at once, whereas in the Non-sparse condition they tended to test switches one by one. Interestingly, children's default strategy shifted with age, with younger children (7- to 9-year-olds) adopting CVS relatively more often in both conditions than older children (10- to 13-year-olds), who tested multiple switches more often. However, there was no evidence for an interaction between age and condition, suggesting that sensitivity to causal sparsity did not change with age. Strikingly, these results show that children as young as 7-9 tailor their learning strategies to the causal sparsity of the system they are presented with, suggesting that children's documented difficulties in learning CVS do not stem from a general inability to grasp the principle of controlling variables. We discuss the potential implications of these results in light of previous findings.

3-B-29 Can preschoolers intentionally forget? Investigating stimulus set type and individual differences in a list-method directed forgetting paradigm

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The ability to intentionally forget information supports the optimization of memory. The directed forgetting (DF) paradigm assesses this capacity in older children and adults. Researchers argue the ability to intentionally forget does not arise until late elementary school, coinciding with improved inhibitory control. However, a recent study has found a DF effect in a sample of 4- to 5-year old children. The present study replicated this finding using two different stimuli sets (picture cards vs. real-life objects). Children ages 36-72 months completed a list-method DF task using picture cards ($n = 65$) or real-life objects ($n = 39$). Results replicated the finding of successful intentional forgetting in preschoolers. Currently, we are investigating how individual differences in metamemory, executive functions (measured using a Day-Night task), and vocabulary (using the Expressive Vocabulary Test, Second Edition) mediate this ability.

3-B-30 The strategic taxation of working memory: Preschoolers attend to belief-violating information at the cost of encoding future, unrelated information

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What role does surprising information play in learning? Research has suggested that surprise is a driving factor in supporting learning. For example, when a novel word is associated with a belief-violating event (e.g., object defying gravity) children are more likely to remember it (Stahl & Feigenson, 2015; 2017). However, we suggest that while surprise may support learning about the surprising events, dwelling on these events will come at the cost of future learning for unrelated information. We investigated this question in a preregistered sample (90% complete) by providing preschoolers with either a belief-violating event ($n=17$; $M=58$ mos), a belief-consistent event ($n=16$, $M=57$ mos), or a low-probability event ($n=15$, $M=59$ mos). Then children were given a new, unrelated associative memory task. Preliminary data

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suggests that children in the belief-violating condition were less likely to learn the information in the associative task, $t(36)=-2.16$, $p=.038$, 2-tailed.

3-B-31 Age of TBI is associated with spatial memory performance

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Traumatic brain injury (TBI) is a health concern with the number of emergency department visits increasing rapidly (CDC, 2017). Among TBI-related emergency department visits, young children (0-4 years of age) have the second highest rate at 1,618.6 per 100,000, right behind adults over 75 years of age (CDC). Various factors include injury severity and age of injury influence the outcome of TBI. There are two possible views of the relationship between age of injury and developmental outcomes: 1) due to greater plasticity at younger ages, earlier injuries may lead to greater recovery and less negative outcomes; 2) brains may be more vulnerable at younger ages leading to less recovery. Effects of TBI on spatial memory are mixed with some studies finding no deficits and others finding deficits (e.g., Anderson et al., 2000; Lehnung et al., 2001), depending on factors such as the severity of the injury, the age of injury, and the type of spatial memory task. Spatial working memory (SWM) develops quickly in early childhood. Therefore, SWM might be prone to disturbance during this period due to its rapid development. Even if an injured person is able to function at normal levels in everyday life, subtle differences in brain function may become more serious if the person incurs further brain injuries or as the person ages. In this study we tested whether a head/neck injury was related to performance on a simple SWM task (Schutte & DeGirolamo, 2019).

C – Spatial and numerical knowledge

3-C-32 Diagnostic accuracy of an early number sense screener using ROC curve analyses

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Strong number knowledge puts children on a path for success in mathematics (NMAP, 2008). Accurate identification of children who struggle with mathematical concepts is a critical piece of successful early intervention programs. However, no reliable and valid screening instruments exist for use across the early school years. The present study examined the diagnostic accuracy of the new Screener for Early Number Sense (SENS), which has three vertically-scaled forms; pre-K, K, and G1. The SENS is based on a theoretical framework about number sense which is operationalized as knowledge of number, number relations, and number operations. Students were screened at the start of their respective school year on the SENS ($n = 150$ at each grade level); then they were followed into the subsequent school year and assessed on the TEMA-3, a widely used standardized measure of mathematics achievement. Correlation coefficients indicate significant ($p < .01$) levels of predictive validity at pre-K ($r = .85$), K ($r = .77$), and G1 ($r = .83$). Receiver Operating Characteristic (ROC) curve analyses, which determine best cut points for practitioners, revealed high levels of diagnostic accuracy as indicated by the AUC: Pre-K AUC = .90; Kindergarten AUC = .76; first grade AUC = .86. If one child is randomly selected from the at-risk population and another from the higher-achieving population, the AUC is the probability of distinguishing between those two students with the SENS.

3-C-33 Does performance to the number line task specifically relate to modulation of neural activation for subtraction problems two years later?

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Behavioral studies have long been trying to find which basic cognitive skills predict later math achievement. Among the many tasks, the number line (NL) task assessing children's formal understanding of the numerical system has shown to predict futures math skill. This task involves both a numerical magnitude processing, that is understanding the numerical quantity of the numbers to be positioned, and a visuospatial process, that is transforming the numerical quantity into a position on a visuospatial line. A previous neuroimaging study with preteens found that the precision on NL task related to the modulation of neural activation for problem size in single-digit subtraction problems. In this study, we ask whether the NL task relates to the modulation of activation for the same problems two year later. Importantly, we examine the specificity of the relation between NL and neural modulation by controlling for basic visuospatial and basic symbolic number sense skills. Using an open source dataset, we selected 20 children who had undertaken extensive behavioral cognitive evaluation and fMRI scans two years apart. At time one, we selected performance on the 0-1000 NL task as our predictor. To assess whether performance to the NL task relates to the neural modulation of single-digit subtraction problems beyond the individual components of which it is constituted, we selected performance to the Key Math Numeration subtest as a proxy for symbolic number sense, and the WASI Block Design subtest as a proxy for visuospatial processing. At time two, we selected the numerosity judgment task and the single-digit subtraction task. Children were selected based on normal IQ, good neuroimaging data and good in-scanner accuracies. We used the in-scanner numerosity judgement task to functionally localize basic numerical processing areas. We found that only visuospatial proficiency two years prior was significantly related to the modulation of activation due to problem size (large vs small). To further understand this relationship, we are conducting behavioral analyses with in scanner accuracies. So far, results suggest that the NL task might be so highly related to later arithmetical skill because of its visuospatial component. Consistent with our findings, larger arithmetical problems, specifically subtraction, recruit more visuospatial processes than smaller arithmetical problems. This study is the first to question the nature of the relation of the NL task in relation to later neural activation for arithmetic processing.

3-C-34 Individual differences in fraction arithmetic learning

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Two central goals for the science of learning are to explain the processes that lead to learning and to explain why different learners display different outcomes. These goals have often been pursued separately, by studying learning processes without considering individual differences or by studying individual differences without a theory of learning processes. In the present study, we addressed both goals simultaneously, by testing predictions about individual differences that were generated by a theory of learning processes. We focused on fractions because of their importance in mathematical development. Fractions are a major focus of mathematics education from fourth to sixth grade. Yet, many children struggle with fractions even after years of instruction. A better understanding of individual differences in this domain could improve educational practice as well as advancing learning theory. Our investigation was based on a theory of fraction arithmetic learning that we previously implemented as a computational model, FARRA (Fraction Arithmetic Reflects Rules and Associations;

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Braithwaite, Pyke, & Siegler, 2017). The theory assumes that children employ similar cognitive processes to learn fraction arithmetic but differ with respect to the parameters governing those processes. To generate predictions about individual differences, we ran simulations in which the model's free parameters were systematically varied. The simulations generated four patterns of arithmetic strategy use: (1) Correct Strategies, in which correct strategies are used for most problems; (2) Addition/Subtraction Perseveration, in which an addition/subtraction strategy is used for most problems; (3) Whole Number/Multiplication Perseveration, in which a multiplication strategy is used for most problems; and (4) Variable Strategies, in which multiple strategies are used for most arithmetic operations. We predicted that children would display the same patterns. Further, the parameter values that yielded each pattern suggested that patterns (1) and (2) would be associated with higher math achievement than patterns (3) and (4). These predictions were confirmed in analyses of two datasets of fraction arithmetic performance among 6th to 8th grade children. In the first dataset, 90% of children matched one of the four predicted patterns. A data-driven technique, Latent Profile Analysis, yielded four latent profiles analogous to the predicted patterns. Latent Profile Analysis of the second dataset yielded four profiles analogous to those found in the first dataset. The predicted variations in general math achievement were found in all analyses. The findings demonstrate that distinct patterns of strategy use exist in fraction arithmetic. These patterns could be a useful diagnostic tool in educational settings for tailoring instruction to the needs of individual students, and thereby improving the effectiveness of instruction, in this mathematical domain and perhaps in others as well. The findings also support FARRA's assumption that individual differences in strategy use result from parametric variation among individuals, and suggest that FARRA's free parameters may correspond to meaningful dimensions of individual differences--specifically, effective learning from errors, consistency versus variability of strategy choices, and presence or absence of initial bias. Understanding the causes of variation in each dimension is an important goal for future research.

3-C-35 Longitudinal development of cognitive maps

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The development of cognitive maps for large-scale environments seems to take time, and to show substantial individual differences. Recent work using a virtual navigation paradigm in 105 children aged 8 to 16 (Nazareth et al 2018) found that children perform at adult levels by around 12 years old. Route representations developed at a steeper rate initially, with slower age-related change for route integration. We have now re-tested 46 children after three years (min = 1.9 years, max= 4.4 years). Overall, there was significant improvement on all navigation measures. However, younger children (11.2 years to 14.3 years) showed significant improvement on within-route pointing and model building but not between-route pointing. Older children (14.4 years to 19.8 years) showed significant improvement in between-route pointing, but not within-route pointing or model building. These data support the idea that proficiency in route representations emerges earlier than route integration. In addition, we report on the longitudinal reliability of the measures.

3-C-36 Mental set in mathematics reduces procedural flexibility and conceptual understanding

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What factors influence whether children use, or shift away from, inefficient strategies? Understanding the factors that impact children's strategy selection has important implications for procedural flexibility in mathematics. The current studies examined how problem-solving contexts impact strategy flexibility and mathematics understanding. Undergraduate ($N=41$; Exp. 1) and fifth- and sixth-grade students ($N=87$; Exp. 2) solved mathematical equivalence problems in one of two set-inducing conditions. Students in the complex-first condition first solved problems that required multi-step strategies, because they did not have a repeated-addend on both sides of the equal sign (e.g., $7+5+9=3+ _$). Then they solved problems with a repeated-addend (e.g., $7+5+9=7+ _$), for which a shortcut strategy could be used (i.e., adding $5+9$). Participants in the shortcut-first condition solved the same problems, but began with the shortcut problems. Consistent with studies of mental set, students in the complex-first condition were less likely to use the more efficient shortcut strategy. In addition, these students were less likely to demonstrate procedural flexibility and conceptual understanding on a posttest. The effects of condition were similar for both children and young adults. Certain problem-solving contexts can help or hinder both flexibility in strategy use and deeper conceptual thinking about the problems.

3-C-37 Student thinking evoked by number line representations of fraction magnitude

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Using worked examples, or written examples of a solution to a math problem, may be particularly helpful for students with math difficulties in decreasing cognitive load. Studying student thinking generated by worked examples of a number line problem focused on equivalent fractions can provide insight into how struggling learners use the number line as a model for understanding equivalence, an important fractions topic. Students ($N=66$ 5th to 11th graders) were entered into the study through a computerized tutoring program when they incorrectly answered a screening problem. Students were pre- and post-tested using fraction items from the National Assessment of Educational Progress. Students were asked to study two equivalence worked examples using the number line. Each example was paired with a prompt that asked them to reflect on problem solving. The current study aimed to a) identify types of explanations students used when reflecting on the worked examples, and b) determine whether these types of explanations were related to pre- to posttest performance. Grounded coding of explanations revealed 3 relevant types of student thinking: using equivalence language (used by 30% of participants), partitioning the number line (28% of participants) and using spatial reasoning (5% of participants). Correctly explaining the worked examples predicted posttest, controlling for pretest ($R^2=.48$, $F(2, 63) = 30.35$, $p = .023$). There is also some evidence that focusing on the equivalence between the fractions, demonstrated by using equivalence language, was related to higher post-test, controlling for pre-test ($R^2=.46$, $F(2, 63) = 28.85$, $p = .058$).

3-C-38 Does analogy help children learn about mathematical equivalence?

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Elementary and middle school students often struggle with understanding mathematical equivalence. Conceptual instruction, which involves directly teaching students about the meaning of the equal sign, has been found to promote learning. In addition, in domains other than equivalence, instructional analogies have been shown to be valuable for student learning. This study investigated whether

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instruction about mathematical equivalence that includes analogy (i.e., solving an equation is like balancing a teeter-totter) is more beneficial than conceptually-focused instruction that does not include analogy or than procedural instruction. We tested 3rd and 6th grade students (current $N = 43$) and examined pretest-to-posttest gains on an assessment of equivalence understanding. Preliminary results reveal that children who received conceptual instruction without analogy showed greater gains ($M = 1.94$) than those who received conceptual instruction with analogy ($M = 1.36$) or those who received procedural instruction ($M = 1.08$). These findings suggest that conceptual lessons with analogy are challenging for children, and a focus on conceptual instruction without analogy may be more beneficial for student learning. Data collection is ongoing; we expect to have a full sample ($N = 120$) before the conference.

3-C-39 Using quantitative labels to promote children's patterning skills

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Emerging research demonstrates a central role of patterning skills in supporting children's cognitive development (see Burgoyne et al., 2017). This study focused on the role of language in supporting patterning skills. Providing common abstract labels across different examples can lead children to find shared structure (e.g., Fyfe et al., 2015; Kotovsky & Gentner, 1996). We focus on several different abstract labels and compare their benefits for children's patterning skills. We hypothesize that quantitative labels (e.g., referring to an AAB pattern as a "two-one" pattern) may be optimal because they can help children "see the math" in patterns and draw attention to the precise quantitative structure. Ninety children (M age = 5.4 years) solved and explained ten pattern abstraction tasks (i.e., recreated a model pattern using novel materials, see Figure 1). Using a between-subjects design, children were taught using one of four labels: letters (AAB, AAB), numbers (112, 112), grouping labels (two-one, two-one), or no labels (this-part, this-part). All three forms of abstract language were beneficial during training relative to no labels. "Grouping" labels that conveyed information about quantity also aided performance on posttest items on which no instructional support was provided. Children's speech and gesture provided further insights into how abstract language may facilitate attention to structure and support early patterning skills.

3-C-40 Framing matters: Relations between performance and math and spatial attitudes

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Math and spatial skills are highly related both concurrently and predictively (Newcombe, 2010). Yet, while we know that children have distinct attitudes about math tasks (Devine, Fawcett, Szucs, & Dowker, 2012), we know very little about children's attitudes towards spatial tasks. Furthermore, we do not know the domain specificity of consequences related to math and spatial attitudes. In the present study, we tested the hypothesis that linking success in the same task to math or spatial skills would yield different relations to domain specific attitudes. Children in early elementary school ($N=138$, M age=8.02) were introduced to a game for children "who are good at": (1) Spatial, (2) Math, or (3) "new" games (Control condition) in which they were asked to judge which of two arrays had more. Children were then given measures of math and spatial anxiety and self-concept. Results revealed framing of the game influenced the relation between performance and math anxiety and self-concept. Performance on the game in the Math game condition ($p's < .05$) and the Control condition ($p's < .08$, marginal) was related to

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math anxiety and math self-concept, but not to spatial attitude measures ($p's > .05$). In the spatial condition, however there were no relations between performance and attitudes for either domain ($p's > .3$). Despite math and spatial attitudes being highly related for all children ($p's < .01$), results suggest that children are sensitive to framing effects in influencing the relation between domain specific attitudes and performance.

3-C-41 Using time diaries to measure parental support for spatial skills

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Several studies demonstrate that engaging in spatial activities, such as playing with blocks or puzzles, is positively related to children's later spatial math abilities, but this work often relies on experimental manipulations (Verdine, Golinkoff, Hirsh-Pasek, & Newcombe, 2014). In contrast, fewer studies examine how families engage with spatial activities in daily life. In this study, we use a novel method of assessing parents' time in spatial activities with their young children. Thirty-six parents of four-year-olds completed two time diary interviews where they reported how they spent their time the prior work and non-work days. Parent reports of the number of minutes spent playing with blocks or puzzles with their children were significantly correlated with a traditional survey measure of spatial activities at home ($r = .39$). Minutes of spatial activities reported in the time diaries were marginally related to children's spatial skills ($r = .29$), whereas the survey measure of spatial activities was not ($r = .07$). Time diaries also demonstrated sensitivity, with minutes of spatial activities unrelated to children's numeracy ($r = .15$). These findings suggest that time diaries provided a discriminant and ecologically valid measure of spatial input at home. This common econometric and sociological method is used less often in psychological research; however, time diaries can fill the gap between structured observations of spatial activities and general surveys of weekly activities.

3-C-42 Parent scaffolding during guided play and children's spatial ability

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Parent scaffolding has been closely linked to children's learning. In the present study, we examined parents' scaffolding behaviors during a dyadic spatial activity, and explored whether these behaviors related to child age and their spatial ability. Forty-five parents and their 4- and 5-year-old child ($M = 4.82y$, $SD = 0.42y$, $n = 25$ females) participated. Children's general and spatial vocabulary, as well as their mental rotation, and performance on two jigsaw puzzle tasks were assessed. Parent-child dyads then used a magnet board to create an elephant from a laminated card. Parent scaffolding, such as their use of gestures, labels and assistance with the activity, was coded. Parents tended to provide more scaffolding for younger children. Controlling for child age, parents provided more scaffolding for children who scored lower on the spatial and puzzle tasks. These results suggest that parents provided greater guidance to children with lower spatial ability.

3-C-43 Relations between children's out-of-school activity participation and mental rotation

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Out-of-school activities--full-body physical, STEM, music, and visual art activities--have been related to spatial skill performance in adolescents. Do specific out-of-school activities relate to spatial skills in young children? Participants were 82 South Korean ($n=40$) and U.S. ($n=42$) 4-year-olds ($M=3.97$, $SD=.45$) and their parents. Parents listed up to five of their children's out-of-school activities, which were categorized as spatial (i.e., full-body physical, such as swimming and ballet; STEM, such as math and Froebel Gift class; music & visual arts, such as violin and art) or non-spatial (i.e., literacy and language; other). Children's mental rotation skill was assessed using an adapted version of the Picture Rotation Task (PRT; Quaiser-Pohl, 2003). Counter to expectations, South Korean children did not exceed U.S. children on the average number of spatial out-of-school activities, $p = .31$, although they did exceed U.S. children on the average number of non-spatial out-of-school activities, $p = .001$. Furthermore, South Korean and U.S. children did not differ in their PRT scores, $p = .34$. Across all participants, the number of children's spatial out-of-school activities did not relate to children's PRT scores, controlling for child age, $r = -.04$, $p = .71$. Findings suggest that 4-year-olds may not have participated in the spatial out-of-school activities long enough to promote their mental rotation performance, unlike adolescents who spend more time in these activities.

3-C-44 Will it fall? The perceptual roots of physical stability in humans

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Although much research has found that humans exhibit a plethora of intuitions when reasoning about the physical environment, few studies have tested the perceptual primitives that may underlie such intuitions. Here we investigated whether children's and adults' stability judgments of objects rely on the geometric centroid of an object, also known as its center of mass (CoM). In two experiments, participants (6-year-olds and college students) judged the direction of falling for an unstable object in a psychophysical task. We found that the point of subjective equality (PSE) for the tipping point of an object scaled as a function of its CoM for both age groups, suggesting that children and adults rely on CoM to predict stability (Exp. 1). Moreover, we confirmed that stability judgments were not instead based on object height and that children's CoM estimates were less precise than those of adults (Exp. 2). Altogether, our results demonstrate a common perceptual mechanism underlying physical judgments of stability that improves in precision across development.

3-C-45 Memory enhancement for conventional, lateralized spatial structure in preschool children

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Children as young as 3 spatially organize ordinal information (e.g., numbers, letters) in a way that reflects their culture's dominant scripted language. In the current study, we explored whether a) information conveyed with the spatial flow of the child's language is preferentially recalled, and b) the social manner in which adults convey information alters children's memory for a scene. Four- and 5-y.o.s in the US (English speakers, left-to-right (LR) script language; $N=62$) and Israel (Hebrew speakers, right-to-left (RL) script language; $N=22$, data collection ongoing) viewed an experimenter lay out a series of numbered, lettered, or colored chips in a LR or RL manner. In the Process condition, the experimenter said "Do you see how I did it? Do it how I did it". In the Means-Ends condition, the experimenter said "Do you see what I'm doing? Do what I do." The board was removed and children were asked to

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recreate the scene, choosing from a set of all stimuli. Children in both cultures recreated the scene more accurately in the Process condition than the Means-Ends condition. Children in Israel recalled RL information better than LR information overall, and RL letter information better than the US children. These results indicate that adult emphasis of the conventionality of spatial structure behaviors enhances memory (across multiple cultures), and that the spatial flow of information enhances memory in a way that is specific to the direction of the child's scripted language.

3-C-46 The role of relative magnitude reasoning in space-math relations

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Studies find associations across many different mathematical and spatial tasks (Mix & Cheng, 2012), with specific spatial processes possibly being important for specific mathematical tasks (Gilligan, Hodgkiss, Thomas, & Farran, 2018). This study tests for a specific relationship between mathematical tasks that require relative magnitude reasoning and spatial tasks that require spatial-relational thinking (Jirout & Newcombe, 2018; Newcombe, Mohring, & Frick, 2018), compared to non-relational spatial and math tasks. Relative reasoning math tasks were symbolic and nonsymbolic magnitude comparison, number line estimation; absolute reasoning math tasks were Give-N and computations (addition and subtraction). The spatial tasks were spatial scaling (relational) and the Children's Mental Transformation Task (non-relational). Preliminary regression analyses show that after controlling for age and gender, performance on spatial tasks predicted performance on the relative ($r^2 = .53$, $p < .05$), but not absolute math tasks ($r^2 = .48$, $p = .062$). Mental transformation did not relate to either set of math tasks (relative: $r = .35$, $p = .15$; absolute: $r = .12$, $p = .65$); spatial scaling related to relative ($r = .62$, $p < .01$) but not absolute math performance ($r = .45$, $p < .06$), though was not significant when controlling for gender and age. Final analyses will include the full sample, contributing to the understanding of common underlying processes that might explain specific space-math relations.

3-C-47 Parent cardinal number gestures encourage children to focus on numerosity

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Cardinal number (CN) gestures have been hypothesized to play a role in children's early number development. CN gestures can be transparently mapped onto the number of items in a set and, as a result, might help bridge the gap between children's innate representations of numbers and number words (Gunderson et al., 2015). Children's knowledge of number words (Levine et al, 2010) and use of CN gestures (Oswald et al., 2019) are both influenced by parental input, but the mechanism underlying this effect is unclear. To explore how CN gestures improve number learning, we coded spontaneous parent-child interactions for (1) parent number words and CN gestures, and (2) child responses. We focused on those parents ($n=32$) who produced CN gestures, which always occurred with number words (e.g., mother says four and holds up 4 fingers). We found that children responded with more numerically relevant responses when their parents used a CN gesture along with a number word than when they used a number word alone (43 vs. 12%). Children not only gave more correct numbers (in this case, the number 4), but also gave more numerical responses that were incorrect (e.g., the number 3), following a number word with a CN gesture than a number word without gesture. These findings suggest that CN gestures not only help children arrive at a correct numerical response, but also help them focus on numerosity per se.

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3-C-48 Understanding the mechanisms of gesture's role in math learning

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In experimental manipulations of gesture in video math instruction, researchers have found that when gesture accompanies speech, it enhances children's learning. There are a few reasons theorized for why gesture improves math learning. One possible explanation is gesture draws attention or highlights relevant instructional information, which then allows children to generalize/transfer what they learned to similar math concepts. The current study examines whether gesture focuses attention for the child learner by comparing instruction with gesture to instruction with yellow highlighting. Fifty-five children ages 7-9 participated in a pretest-instruction-posttest-retention design to teach children mathematical equivalence (i.e., $3 + 4 + 5 = _ + 5$). During instruction, three different classrooms were each assigned to watch one of the following video instructions: (1) speech instruction with gesture, (2) speech instruction with highlighting, or (3) speech instruction only. Preliminary results showed that children benefited more from speech instruction with gesture and with highlighting than from speech only instruction. However, speech instruction with gesture was more likely to improve concept generalizability/transfer and retention after two weeks than speech instruction with highlighting. These results suggest that the spatial representation in gestures may provide a rich conceptual representation that benefits deep and sustained learning through an instructional video.

3-C-49 First things first: Identifying profiles of low-income preschoolers' numerical abilities to inform intervention designs

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To best support children's mathematical learning it is important to consider how early abilities develop in concert. Previous research has investigated early math ability profiles of young children, but none has focused specifically on the numerical skills of children from low-income households, who tend to lag behind mid-income peers. The present study aims to describe patterns of low-income preschoolers' numerical skills, which can then inform the design of targeting training programs. Head Start preschoolers ($n=115$) were given six numerical assessments (verbal counting, numeral identification, object counting, give-a-number, symbolic and non-symbolic magnitude comparison). A latent profile analysis revealed four profiles as the best-fitting model. Children were classified as having: a) poor math abilities on all measures, $n=13$; b) strong math abilities on all measures, $n=41$; c) moderate abilities in counting, numeral ID, and cardinality, and above-chance performance on both magnitude tasks, $n=35$; and d) strong abilities on counting, numeral ID, and cardinality, but at-chance performance on both magnitude tasks, $n=26$. Our results suggest that there are qualitative and quantitative differences in children's numerical skills across profiles. While many children in our sample would benefit from additional exposure to all types of numerical skills, approximately one-third of participants showed strong understanding of basic numerical skills but lack proficient magnitude skills.

3-C-50 Factors predicting parental math input with their preschool-aged child

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Parents' talk about math with their child is related to children's math skills (Elliott et al., 2017). Previous work examined either parent use of number words or combined all types of math talk. No work focused solely on math elicitations, i.e., utterances intended to evoke a math response, which parents may use to scaffold attention to and teach children about math. Here we look at math elicitations and number words separately and identify factors that predict parent use of each type of input. 146 children (M age=3.9 yrs) and one parent participated in a short free play, where parent use of math elicitations and number words was coded. Parents also reported their math attitudes, math anxiety, beliefs about math importance, how often they do math activities with their child (LeFevre et al., 2009), and parents and children completed standardized math tests (Woodcock et al., 2001; Baroody & Ginsburg, 2003). Parent math attitudes significantly predicted their use of number words and math elicitations ($p < .04$) even controlling for all other measures and overall amount of talk. Parents who enjoy math used more math input. Critically, parent math ability only predicted use of math elicitations ($p = .01$); parents with higher math ability used fewer elicitations. Perhaps parents who do well in math expect their child will also, and do not feel the need to intentionally elicit math responses from them. This suggests parents may use elicitations and number words with different goals.

3-C-51 Shape fitting in preschool children: Matching positive space to negative space and negative space to positive space

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Most object fitting work has focused on fitting a shape (positive space) into a corresponding aperture (negative space), and not on the reverse problem of fitting negative space (an aperture embedded in a surround) onto positive space. Here we directly compared the two forms of fitting in counterbalanced order. In the positive to negative fitting task, children ($N=44$; 18-36 months) selected one of three towers that would fit into an aperture embedded in a surround. In the negative to positive fitting task, the same children selected amongst three differently shaped objects to fit onto a tower that matched the shape of only one of the apertures. Objects and apertures included all combinations of a circle, square, or triangle, so that congruency/incongruency of the aperture's shape and its solid surround varied systematically. Results indicated that performance increased with age. Additionally, no difference in performance between the two fitting tasks, and no sex differences were found. Finally, younger children were more negatively affected by incongruency than older children in some conditions, suggesting difficulty in overcoming the influence of the shape of the surround.

3-C-52 Math anxiety relates to symbolic, but not non-symbolic calculation accuracy

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The cause of math anxiety and its relation to math performance is complex. Social learning may lead to math-focused anxiety which depletes domain general cognitive skills necessary for mathematics. Another possibility is that poor numerical magnitude representation leads to math difficulties and subsequently math focused anxiety. Non-symbolic calculation offers a unique opportunity to test the latter hypothesis, because non-symbolic math tasks involve calculation with non-symbolic numerical magnitudes without mathematical symbols. If high math anxiety is due to deficits in magnitude processing, participants high in math anxiety should also perform poorly on tests of non-symbolic math calculation. To test this hypothesis, we examined the relations between math anxiety, math

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performance, and novel measures of symbolic and non-symbolic approximate calculation performance. Three hundred eleven college undergraduates and one hundred sixty-five second to fourth graders (6 to 9 years old) completed measures of math and reading anxiety, symbolic math, non-symbolic numerical comparison, reading ability, and non-symbolic approximate calculation. Math anxiety scores explained unique variance in symbolic, but not non-symbolic math performance in both children and adults. Moreover, non-symbolic magnitude processing and math anxiety contributed unique predictive power to symbolic math performance. Our data suggest that math anxiety is specifically related to symbolic mathematics and that it does not stem from deficits in magnitude processing. Future research should test whether non-symbolic calculation is an effective way to introduce mathematical concepts to math anxious students.

3-C-53 The role of digit identity in 5- to 8-year-olds' numerical estimates

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Number line estimation (NLE) is widely used both as a task to investigate the nature and development of numerical cognition and learning, and as an instructional tool. A nearly universal assumption underlies this work - the idea that performance is ultimately driven by numerical magnitudes of target numerals while the specific digits instantiating those magnitudes is irrelevant. Recent experiments (Lai, Zax, & Barth, 2018) show that this assumption is incorrect: Children's (ages 7-11) and adults' estimates are strongly influenced by the leftmost digits of the target numerals in 0-1000 NLE tasks. Here, we explore the generality and development of this left digit effect with a 0-100 NLE task in younger children (N = 73, children ages 5-8). Eight-year-olds, but not 5-to-7-year-olds, showed a left digit effect, demonstrating that (1) the effect occurs for tens digits as well as hundreds digits and (2) it appears to emerge at approximately the same age for both two-digit and three-digit numerals.

D - Linguistic and conceptual development

3-D-54 Investigating children's learning at multiple levels from shared reading

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Reading picture books supports children's learning of new words, as well as social skills and moral understanding (e.g. Bus et al., 1995; Larsen et al., 2018), all of which predict academic success (Cooper et al., 2014). Previous research has investigated these different types of learning in isolation; however, picture books contain information that can be extracted at many different levels, including details about story events, meanings of novel words, and overarching lessons (Horst et al., 2015). In the current study, we ask whether children can learn story details, words, and moral lessons simultaneously from a picture book. Children (4.5-5.5 years, N=20 to date) participated in a shared-reading interaction with a parent. Children's learning of story details was assessed with a series of yes/no questions, learning of novel words from the story was measured with a 4AFC image-selection task, and moral-learning was tested with a matching task where children were asked to select a novel vignette with the same moral lesson as the story. Children performed above chance on all tasks (Story details: $t(19)=16.25$, $p<.001$; Word-learning: $t(19)=6.74$, $p<.001$; Moral-learning: $t(19)=3.05$, $p=.007$), indicating that children can successfully engage in learning at multiple levels during the same reading interaction. However, not all

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children learned successfully at every level; ongoing analyses are exploring how variation in parental behaviors relate to children's learning.

3-D-55 Investigating the emergence of person perception in preschool children through natural conversations with their parents

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Person perception refers to the process by which we form impressions of other people, often through behavioral observations (Ambady & Rosenthal, 1992). The present study investigates the processes by which children learn about person perception through conversations with their parents. We expected that children would be exposed to personality trait information from their parents early on, and would also begin using these terms themselves at a similar age. We also expected that the way children used trait terms would change as they aged. The transcripts of four children were obtained from CHILDES (MacWhinney & Snow, 1985): Abe (Kuczaj & Maratsos, 1975), from 28 to 60 months; Adam (Brown, 1973), from 27 to 62 months; Sarah (Brown, 1973), from 27 to 61 months; and Naomi (Sachs, 1983), from 14 to 57 months of age. A subset of transcripts was independently line-coded to identify all potential person perception terms, which were then grouped into the following categories: good, bad, nice, mean, smart, silly, quiet, careful, funny, and friendly. Additionally, terms were classified as being either a "trait (T) term" (that directly described a person, e.g., "nice girl"), an "action description (AD) term" (that described a person's actions or actions observed in a situation, e.g., "you're gonna be mean"), or neither. Afterwards, all transcripts were searched for terms belonging to the ten person perception categories; the targets of the terms were also identified. Overall, children were exposed to person perception terms at an early age. That is, the first person perception terms produced by the parents appeared in the earliest transcripts for Abe, Adam, and Sarah, and in Naomi's transcript at 18 months. Similarly, children began producing these terms early on; the first person perception terms produced by the children appeared in the earliest transcripts available for three of the children (Abe: 28 months, Adam and Sarah: 27 months) and in one of Naomi's earlier transcripts (21 months). In total, 2641 terms were identified, of which 1062 terms (40%) were classified as T terms and 1579 (60%) were classified as AD terms. Analyses revealed that proportionally, parents produced more AD terms, whereas children produced more T terms, $\chi^2(1, N = 2641 \text{ terms}) = 240.93, p < .001$. However, as children aged, the proportion of AD terms increased while the proportion of T terms decreased. Further examination revealed that both parents and children tended to use these terms in an evaluative manner (e.g., whether the target was "good"); and on the whole, these evaluations were directed towards the target children, both by their parents (75.09%) and by the children themselves (35.95%). Finally, we found that children used T terms to explain the behaviors described by themselves or by their interlocutor quite often (Adam: 23%; Abe: 42%; Naomi: 32%; Sarah: 34%). Across the ten categories, the frequency of these explanatory usage terms was highly correlated with the number of T terms children produced, Spearman's $r = .95, p < .01$. Our findings show that children are exposed to person perception terms at a young age. They rapidly learn how to apply these terms to the actions in which people engage and they often invoke the terms in offering explanations of those actions.

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3-D-56 Word-referent co-occurrence during home activities

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Much research on object name learning focuses on how infants disambiguate the referent in moments that referent and its name are present. However, recent work shows that speech to infants in their daily lives is infrequent during two common activities: mealtime and playtime, the latter of which is often studied as the ideal object name learning context (Tamis-LeMonda et al., 2018). Other recent work shows that the co-occurrence of an object and its name is rare in the mealtime context (Clerkin & Smith, 2019). Taken together, these results suggest that the object name learning context in the real world may be very different - in its basic statistical structure - from the experiments researchers conduct in the laboratory. Thus, in the present study, we examine object-name co-occurrence in the playtime context using a corpus of head-camera images collected from 7-11-month-old infants in the home to better understand the data for learning object names.

3-D-57 The development of subordinate-level categorization: Kinds and brands

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Among the three primary levels of object categorization (superordinate, basic and subordinate), the subordinate has perhaps been the least well studied (Murphy, 2003). Discussions of subordinate-level artifact categories often conflate kinds and brands (e.g., treating both convertible and Corvette as subordinate to the basic category car). Yet subordinate kind categories (convertible) and subordinate brand categories (Corvette) have different criteria for membership - intended function for kind categories (Matan & Carey, 2001), but maker identity for brand categories. Participants (240 4- to 7-year-olds and adults) completed a forced-choice match-to-target task in which they extended a novel word from a target artifact (e.g., a glove) to one of two other artifacts. One was a subordinate kind match with the same intended function but a different maker; the other was a subordinate brand match with a different intended function but the same maker. The novel word was modeled as a term for either the kind ("This kind of glove is called a POGON") or the brand ("This brand of glove is called POGON"). By five years, children extended the kind term systematically to the subordinate kind match; by seven years, they extended the kind term systematically to the subordinate kind match and the brand term systematically to the subordinate brand match. By the age of seven, children thus acquire two distinct ways of sub-categorizing artifacts - by kind and by brand.

3-D-58 The development and representational nature of center-embedded, recursive sequences

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The ability to represent center-embedded, recursive structures (those which allow elements to be embedded within elements of the same kind, e.g. "[{ }]"), is thought to be a critical feature of human syntax and has been implicated in the development of a number of human capacities such as language and mathematics. It is currently unknown when the ability to represent recursive structures develops in young children as well as what underlying sequential processes are used to represent such structures. Using a non-linguistic sequencing task, we provide evidence that children can extract the underlying

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center-embedded nature of sequential lists and generalize this structure to novel instances by the age of 3.5-years-old. We also test proposed mechanisms for representing these types of structures: a stack-like data structure - a first-in-last-out structure in which only the last item can be accessed, and a queue-like data structure - an ordered list that can only be accessed from its beginning. By comparing center-embedded sequences (e.g. A1 A2 B2 B1) and cross-serial structure (e.g. A1 A2 B1 B2), we show evidence that both center-embedded and cross-serial structures are stored using a queue-like representational system which iteratively runs forwards searches through a stored queue.

3-D-59 The effect of fantasy worlds on children's judgements of possibility

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In two experiments, we investigate whether children are reality-prone when reasoning about the possibility of events in fantastical worlds. In Experiment 1, children aged 4-6 (N=180) heard about improbable, impossible, and illogical events, and were either asked if the events could happen in a dream or in reality. For dreams, children mostly agreed that improbable events could happen, $p=.001$, responded at chance for illogical events, $p=.370$, and were marginally likely to deny that impossible events could happen, $p=.052$. For reality, children mostly denied that any event could happen, $ps<.001$ (Figure 1). In Experiment 2, children aged 5-6 (N=60) heard about different events and were asked if they could occur in a dream, a story, or reality. The events were impossible, but more typical of dreams and stories than those from Experiment 1 (e.g. meeting a talking squirrel, flying through the sky). Children mostly agreed that the events could happen in dreams and stories, $ps\leq.002$, but mostly denied that any event could happen in reality, $p<.001$. However, children more often agreed that the events were possible in a dream than in a story, $p=.033$ (Figure 2). The findings show that children do not apply realistic principles indiscriminately and universally when deciding whether events are possible in fantastical worlds. Further, they suggest that the typicality of an event may contribute to children's beliefs about its possibility in the absence of a richer causal understanding.

3-D-60 Birth-order effects on vocabulary persist throughout the lifespan

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While all typically-developing children acquire a language, it is well-established that their early environment can affect how quickly linguistic skills develop (Weisleder & Fernald, 2013). Given that language is the conduit through which we learn most of what we know, there is considerable interest in better understanding the role of environment and identifying effective interventions. Birth order provides a powerful natural experiment. The linguistic input varies significantly for children of different birth orders (Oshima-Takane & Robbins, 2003). Most saliently, younger children receive large amounts of input from inexpert speakers. It is unclear whether this should lead to worse learning (less direct parental input) or better (a simpler model to learn from). The results so far are scanty and contradictory (Berglund, Eriksson & Westerlund, 2005). Moreover, they focus on infant language, leaving open the possibility that any effects are temporary. We assessed the vocabularies of 108,312 English-speaking individuals (ages: 4-91). The subjects were volunteers who were recruited online using a well-established platform that has been extensively validated [citation suppressed for anonymity]. The test consisted of 20 trials that involved choosing from among five words the word most related in meaning to a single target word, as in (1): (1) Life: existence serum existence stake bundle denial We analyzed

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subjects separately based on number of children in the family. This avoids the well-known confound between birth order and family size: latter-borns are necessarily more likely to come from large families (Hartshorne, Salem-Hartshorne & Hartshorne, 2009). Family size is an important demographic variable in its own right, and also correlates with many others, such as socio-economic status. Focusing initially on native English speakers, we indeed find an effect of family size: for a given birth order, individuals from larger families knew more words (Fig. 1; most $ps < .05$). Critically for our research question, within sibship sizes of 2-4, the 1st-born had a larger vocabulary ($ps < .05$). (We did not analyze larger sibships due to insufficient N.) Evidence for differences among 2nd, 3rd and 4th-borns was less clear. As shown in the Figure, this 1st-born advantage persisted across most if not all of our age range (most $ps < .05$), at least for family sizes of 2 and 3 (there were too few families of 4 to analyze). Interestingly, results were similar for non-native English speakers who were not immigrants and thus were unlikely to have learned English in a family setting. Although the data were noisier, first-borns tended to have larger vocabularies across different family sizes ($p < .05$). This effect persisted across much of the lifespan, at least for sibships of 2 (the only subset large enough to analyze) (most $ps < .05$). Thus, while there is a clear effect of birth order on vocabulary size that persists through adulthood, it may not operate directly on language acquisition. One possibility is that intelligence acts as an intermediary: first-borns have slightly higher average IQs, and vocabulary is heavily g-loaded (Bjerkedal, Kristensen, Skjeret & Brevik, 2007). We discuss these results in the broader context of research on family environment, birth order, intelligence, and their interactions (Berglund et al., 2005; Hartshorne et al., 2009; Bjerkedal et al., 2007; Damian & Roberts, 2015; Oshima-Takane & Robbins, 2003).

3-D-61 Productivity patterns during English tense-marking acquisition in dual language learners

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Dual language learners (DLLs), children who are in the process of acquiring two languages, have been reported to exhibit substantial individual variation in their grammatical ability (Paradis, Rice, Crago, & Marquis, 2008). This study explored individual differences in grammatical skill by examining the onset of English tense marking (e.g., past -ed; third person singular) in Spanish-English DLLs with typical language development. Twenty-eight narrative retell language samples from five- and six-year-old DLLs, who were in kindergarten and first grade, were analyzed for accurate and productive use of English tense morphemes. Specific focus was given to identifying patterns that DLLs displayed while acquiring productive use of these grammatical forms. Additionally, data were examined for potential relationships between children's productivity scores (i.e., productive type total and tense and agreement productivity) and their accurate production of tense morphemes. The findings of this study will help to refine and advance our understanding of the developmental patterns that Spanish-English DLLs can demonstrate while attaining English tense morphology, as well as expand the evidence base concerning their varied language abilities.

3-D-62 The development of a naïve psychology of superstition

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Children often appeal to supernatural forces to explain life events. Indeed, research shows that believing in superstitious rituals can influence the outcome of events--but via natural mechanisms like altering

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one's persistence rather than through magical forces. To what extent are people aware that superstitions can work this way? Research suggests that such awareness is uncommon among lay adults, however initial findings from our lab show that even children may demonstrate this sophisticated reasoning. Five- to 8-year-olds were read 4 stories describing children who perform a superstitious ritual (e.g., a boy who stomps his feet 3 times before soccer games) and then experience a positive outcome (e.g., winning a game). After each story, children were asked an open-ended question about how the behavior could have led to the outcome. Responses were coded into 3 categories: supernatural, natural-psychological, and other (non-explanations, denying the connection). Appeal to natural-psychological explanations (e.g., "[the ritual] made her feel comfortable"; see Figure 1) was present among children of all ages, however older children were more likely to appeal to natural-psychological explanations than were younger children ($p < .05$). These results provide provocative evidence that children understand the natural benefits of superstitious rituals and also suggest that superstitious belief may be overestimated in some studies.

3-D-63 Delineating the semantic space for support (ON) in early language development

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The spatial term ON (and cross-linguistic equivalents) is prominent by age 2-3. This is striking given that ON can apply broadly; it can refer to objects supported via solid support from below (SFB: teddy on table) or by other mechanisms (picture hung on wall). Such support mechanisms embody different types of 'force dynamic' interactions that result in support of one object by another. Given this broad usage, is there is any privileged representation of support that guides children's learning of language that encodes support? Two studies suggest there is. Studies 1 and 2 tested the hypothesis that differentiation between SFB and other support types appears in the earliest stages of language production and comprehension. Previous studies have shown that by 4 years of age, children linguistically differentiate support types, using the construction BE ON (the Basic Locative Construction) to encode SFB but lexical verbs (e.g., stick, hang) to encode mechanical support. In Study 1, children ($N = 28$; M age = 3.36 years) were shown a messy playroom and asked to help two children find their missing toy. They were then shown 15 different spatial support configurations (5 SFB, 5 hanging, 5 adhesion) and asked "Where should we look for the toy?". Children used the BLC in English (is on) more often to encode SFB than either type of mechanical support (see Figure 1). In Study 2, children ($N = 30$, M age = 3.5 years) were shown the same spatial support configurations as in Study 1, and heard two characters giving two different descriptions of the toy's location (e.g., "I say it is on the vase" vs "I say it is sticking to the vase"), and were asked "Who said it best? For mechanical support relations, when given a choice between is on and a lexical support verb (sticking to), they chose the latter (binomial tests; $ps < .01$). In sum, SFB is privileged in the early development of spatial language encoding support: Configurations with support from below receive the 'most basic' encoding: BE ON. These findings raise questions about how children learn to encode non-SFB configurations, and make clear that learning the verbs that partner with prepositions is an important part of that learning.

3-D-64 Representing mere possibilities

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Acting effectively in a world of uncertainty requires taking the possibilities into account. But how do we represent mere possibilities, in addition to actual facts? Actual facts are always consistent with one another, but possibilities can conflict. How can we maintain a consistent model of the world while accounting for conflicting possibilities? Redshaw and Suddendorf (2016) tested children's and apes' sensitivity to conflicting possibilities. They dropped a desirable target into a plastic tube shaped like an upside down "Y". There were two places the target could emerge; they checked if participants would cover both places when preparing to catch. Apes and children younger than 3 failed spectacularly, almost always covering only one outcome. Thus they did not account for conflicting possibilities when planning their action. 3 year olds covered both outcomes after a few trials, and many 4 year olds covered both outcomes from trial 1. But truly representing possibilities requires being able to contrast the possible with the impossible. The Y-shaped tube does not test whether participants can make this contrast. We added an impossible outcome to the Y-shaped tube. Now, to guarantee a catch, participants must anticipate where the marble might emerge without getting distracted by the place where it can't. On the Y-shaped tube 36 month olds used two hands 50% of the time. When we added an impossible outcome they still used two hands half the time, but only got them in the right places on about 15% of trials. They struggled to distinguish the possible from the impossible. 48 month olds were better, but far from adult performance on this simple task. They were correct on 62% of trials with the Y-shaped tube and on 43% of trials when there was an impossible outcome. Experiment 2 had a pretest-posttest design, using the tube with one impossible and two possible outcomes. Between tests, we drew participants' attention to the physical features of the tube. We wanted to check (1) if children were making unexpected physical assumptions or pragmatic interpretations that could be dispelled by talking about the physics of the tube; and (2) if learning from the intervention and across trials was influenced by age. 48 month olds improved steadily across trials, but 36 month olds improved little. The intervention helped 48 month olds but not 36 month olds. It is unlikely that 36 month olds' difficulties arise from unexpected physical assumptions or pragmatic interpretations of the task. We will argue that the ability to represent possibilities as such is an extension of more fundamental and early emerging cognitive capacities. These include the ability to (1) construct a model of the world that includes the results of a simulation into the future; (2) consider a sequence of possibilities in series without comparing them to each other, as in serial search; (3) switch between multiple models, as in pretend play. Existing tasks that claim to show representations of possibilities in infants and young toddlers may be reflecting these more fundamental cognitive abilities. We propose that representing mere possibilities requires generating mutually exclusive models of a single reality and comparing them to one another, holding each in mind as candidates for the actual. At least one model must be marked as merely possible, distinguished from what is currently taken to be actual, but a candidate for becoming the actual model pending further information.

3-D-65 Electrophysiological evidence for phonological but not semantic processing in 4-year-olds' cross-situational word learning

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'Cross-situational' word learning (CSWL) refers to young children's ability to learn new word-object links by tracking their co-occurrences across learning events (e.g., Yu & Smith, 2008). To date, studies have assessed CSWL using young children's eye-gaze and pointing behaviors in response to a forced-choice comprehension question (e.g., "can you point to the bosa?"). Although these testing procedures reveal

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that some kind of learning has occurred as a result of the cross-situational exposure, they are not informative about the nature of these representations underlying that learning. One possibility is that children have learned a true semantic representation, as is typically thought to be the hallmark of word learning. An alternative is that children have learned a more perceptual representation that reflects registration of the co-occurrence of the word and the referent, but without attaching semantic meaning. To investigate between these possibilities, we recorded 4-year-olds' event-related potentials (ERPs) in a picture-word matching task (Desroches, Newman, & Joanisse, 2009) following CSWL. Fifteen 4-year-olds were fitted with a 128-channel geodesic sensor net and first completed a CSWL task in which eight novel word-object pairings were repeatedly presented four times each. After a 5-minute delay, we recorded children's ERPs in a picture-word matching task, where a target picture was followed by an auditory word that either matched or mismatched the target. When comparing match and mismatch trials, two ERP components emerge that are thought to dissociate phonological and semantic processing. The first is the phonological mapping negativity (PMN), which occurs between 250 and 300 ms post-stimulus over midline fronto-central sites, and is sensitive to differences in the expected versus perceived phonological form of a word (Connolly & Phillips, 1994). The second is the N400 effect, which occurs approximately 400 ms post-stimulus over centro-parietal sites and is sensitive to semantic violations (Federmeier & Kutas, 2011). If children encode semantic representations as a result of CSWL, then they should show a robust PMN and N400 on mismatch trials. If, alternatively, children have only registered the co-occurrence of the word and the referent, then they might show the PMN but no N400. A 'whole-head' cluster-mass analysis comparing ERPs to match and mismatch trials showed that children demonstrated a robust PMN over a group of centro-parietal electrodes (62 [Pz], 78, 79, 80, 85 [P2], 86, and 87[CP2]) from 220 to 324 ms, $t(14) = -3.08$, $p = .008$ (Figure 1). The PMN peaked at an average of 292 ms over these electrodes. Results also showed an earlier divergence from 60 - 116 ms with a similar spatial distribution as the PMN (Figure 1c). There was, however, no evidence of a reliable N400 effect. These findings suggest that 4-year-olds encode robust perceptual representations for new words trained in a CSWL task and may not encode semantic representations for the words. The earlier divergences may reflect early lexical access (Penolazzi, Hauk & Pulvermuller, 2007). More broadly, these findings indicate that irrespective of whether children attend to and encode co-occurrences between words and its referent during CSWL, more is needed to acquire a meaningful relation.

3-D-66 How children and parents make sense of robots

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We investigated how aspects of families' lives may relate to how they make sense of robots. Our approach integrates sociocultural and constructivist theories of development and considers how children learn through everyday social interactions. Data were collected at a children's museum located in Silicon Valley, a relevant context to evaluate media reports suggesting that parents in the tech industry are more restrictive with children's use of technology than those outside of the industry. 73 parent-child dyads with children ages 3-6 participated in the study. Dyads interacted with a mobile robot in structured play, parents completed questionnaires about technology beliefs, and then dyads engaged in a sorting task. Dyads sorted images as robots or not-robots. Stimuli included natural kinds, robotic objects, and mechanical objects (washing machine, toy car, toaster). Regardless of their occupations, parents reported similar restrictions on their children's technology use, $t(72) = 1.68$, $p = .098$. Parents in the tech industry expressed fewer, not more, concerns about technology than parents outside of the

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tech industry, $t(72) = 2.25$, $p = .027$. In the sort task, categorization of objects was unrelated to parent occupation. Nearly all families sorted the natural kinds and robotic objects as expected. However, families varied in how they sorted mechanical objects. Coding conversations will reveal how dyads discuss and reason while making these ambiguous categorical distinctions.

3-D-67 Caregiver literacy practices with infants at 9 months and child vocabulary skills at 36 months: Findings from an Irish cohort study

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We examined early reading to infants and vocabulary skill at 36 months using data from the National Longitudinal Study of Children in Ireland ($N=8,632$). 81% of caregivers read to infants at 9 months. Higher levels of education and income were associated with increased likelihood of reading whereas maternal depression was associated with not reading to infants. Reading to infants predicted the frequency of shared reading at 36 months ($\chi^2(2, N=7467)=75.53$, $p<.001$), the number of children's books at home at 36 months ($\chi^2(2, N=7467)=15.14$, $p<.001$), and children's vocabulary skills at 36 months ($F(7104)=24.62$, $p<.001$) even after controlling for literacy and SES variables at 36 months. The findings highlight the importance of early literacy practices for children's vocabulary development.

3-D-68 What do you want to learn? Children selectively choose books to fill gaps in biological explanations

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This study examined whether children selectively chose books to read that would enhance their learning about science. Children ages 7 to 10 ($N = 90$) listened to conversations in which a character asked a question about an animal's behavior and a second character provided an explanation that was either complete or missing a key part of the mechanism. Following each explanation, children indicated how much information they thought was missing from the explanation. After hearing one pair of items (i.e., one animal question with a complete explanation and a different animal question with an incomplete explanation; five pairs total), children chose between two books to read: one on the topic of the complete explanation and one on the topic of the incomplete explanation. Children also completed a measure of general biological knowledge. Overall, children recognized that incomplete explanations were missing more information than complete explanations, $t(89) = 8.67$, $p < .001$. They also showed selective learning behaviors: they preferred books related to the topics of the incomplete explanations over ones related to the topics of the complete explanation, 2.91 out of 5 books, $t(89) = 3.05$, $p = .003$. In addition, the greater children's general biological knowledge, the more likely they were to select books about incomplete explanations that could fill gaps in their understanding, $r(88) = .32$, $p = .003$. Implications for children's learning will be discussed.

3-D-69 Infant language ability and nonverbal emotion matching: Crucially connected or independent skills?

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Recent theories suggest that language may be crucial for emotion concept development. However, the majority of research relating these two skills uses linguistic tasks to test emotion understanding, making it difficult to isolate children's emotion knowledge from understanding the task or instructions. We assessed vocabularies of infants between 15 and 18 months as well as their ability to match emotions across different faces using an entirely non-linguistic task. Parents completed the MCDI to report their child's productive vocabulary. Infants participated in a non-linguistic eye tracking emotion matching task. Infants viewed 24 trials with a woman's face depicting an emotion (afraid, angry, happy, or sad) for 3 seconds, followed immediately by two emotional faces of a new woman, one matched to the previously displayed emotion and the other mismatched, for 5 seconds. Additionally, infants viewed trials that involved matching the shape of novel objects to control for general matching ability. Preliminary data from 29 infants (Mage=16.54 months, 11 male) revealed that infant vocabulary trended toward predicting nonverbal emotion matching ($R^2=.124$, $p=.071$). However, when controlling for novel object matching, there was no longer a trend toward significance ($R^2=.071$, $p=.146$). Although additional data are needed, the current results suggest that language may predict emotion matching, but part of this relation may be accounted for by other general cognitive skills.

3-D-70 12-month-old infants rely on other people's knowledge when responding to speech about absent objects

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Around 12-13 months of age, infants learn to respond to the mention of hidden absent objects by looking, pointing or approaching their locations. They mostly engage in these behaviors when the referent is easily accessible. When it is inaccessible (e.g., hidden on a shelf) about 25-44% of infants respond (Osina et al., 2017). One potential explanation is the pragmatic oddity of the situation when the same adult puts an object out of reach and then asks the child to find it. We tested whether infants (13 months) would be more likely to respond if one person hid an object, but another asked them to find it. For one group of infants (N=16), the researcher played with a toy, switched with another person who hid the toy on a shelf, and then came back for the test (inaccessible ignorant condition). For the other group (N=16), the researcher hid the toy herself, then briefly switched with another person, and then came back for the test (inaccessible knowledgeable). Both groups were also tested with an object hidden on the floor (accessible). As expected, infants responded robustly in the accessible object condition (87% and 81.25%). However, infants did not respond significantly worse ($p's > 0.1$) in either of the inaccessible conditions (68.75% in both groups). Likely, when the researcher left the room after hiding the toy and came back later to ask the child to find it was more pragmatically natural than the original inaccessible condition, and infants were sensitive to that.

3-D-71 Verbal framing affects children's structural attributions for inequality and intergroup attitudes

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From a young age, children intuitively attribute observed social differences to intrinsic, essentialist causes (e.g., genetics, biology) rather than extrinsic, structural causes (e.g., opportunities, resources). While essentialist reasoning has been shown to facilitate prejudice in some cases, the impact of structural reasoning is less understood. In the present study, we taught child participants ($n = 106$)

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about a status difference between novel social groups: One group won a game against another group, and the victory could always be attributed to either an intrinsic cause (the biology of the creatures) or an extrinsic cause (the structure of the game). We narrated the game with either intrinsic, neutral, or extrinsic framing in three between-subjects conditions and assessed participants' causal attributions (e.g., "why did that group won the game?") and social preferences (e.g., "who do you want to be friends with?"). Participants in the extrinsic framing condition made fewer intrinsic and more extrinsic attributions compared to participants in the intrinsic and neutral framing conditions, who made mostly intrinsic attributions at similar rates. Participants generally showed a friendship preference for the high-status group, in line with previous research, but on trials for which extrinsic attributions were made, participants showed no such preference. Results have implications for intergroup prejudice development, causal reasoning and explanation.

3-D-72 Accent-related biases in children's credibility judgments

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Adults are more likely to believe statements made by native-accented than foreign-accented speakers. Though accent-related biases associated with learning and peer preferences have been found in young children, credibility biases have not been tested in children. Thirty-nine 4- to 6-year-old children from an urban area in the Southwestern United States were introduced to two puppets: one "spoke" with a foreign accent (FA) and one "spoke" with an American English accent (EA). FA sentences were prerecorded by native Chinese, Hindi and Bengali speakers and the EA by native English speakers; statements were pretested to verify comprehensibility and perceived accentedness. Each child heard a single FA and single EA speaker. Children were shown a sequence of 16 pictures of familiar and unfamiliar entities. Both puppets provided equally plausible, but contradictory descriptions of each entity (e.g., this aye-aye eats bugs/eggs). Statements were designed so that accuracy could not be discerned from the pictures or prior knowledge. Children were asked to select which speaker they believed to be correct. Children more readily accepted statements provided by the EA puppet ($M = 8.9$) than the FA puppet ($M = 7.1$), $t(38) = 2.04$, $p < .05$. This suggests that, like adults, children treat native-accented speakers as more credible than foreign-accented speakers. Discussion will focus on possible explanations and implications of preferences for native-accented speech.

3-D-73 Can reading personalized storybooks to children increase their prosocial behavior?

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The purpose of this study was to examine whether for 4- to 5-year-olds perceived similarity with the main character of a storybook makes them more likely to engage with, remember, and learn the moral lesson of a story. In our study, children were read either a personalized or non-personalized story about sharing, or a control book about a plant. In the personalized story condition, the main character's name and gender were changed that of the participating child. After listening to the story, children answered comprehension questions, retold the story themselves, and then participated in a sticker sharing task. We assessed children's use of self-references (e.g., "that's like me!") and overall extra-textual talk during the story listening and retelling, their accuracy in comprehension of the story and its moral, and also their prosocial behavior through sticker sharing. In accordance with previous literature, we found that while participants who were read a personalized version of the sharing story produced more

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spontaneous speech and self-references during the book reading, they were no more likely than children who heard a non-personalized sharing story to understand its moral or to act on that moral by actually sharing more stickers. Contrary to our initial hypothesis, perceived similarity with storybook characters is not enough to cause increased prosocial behavior despite a prosocial story moral.

3-D-74 How do children learn novel emotion words?: A study of emotion concept acquisition in preschoolers

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Despite the importance of emotions in our daily lives, little research examines how children come to understand emotion words and map them to emotion concepts. Linguistic evidence suggests children use the sentence frame a word occurs in when acquiring novel words in general. With emotion concepts specifically, growing psychological research shows that children use the situational context to construe meaning. In two experimental studies and a preliminary archival analysis we examine the role of both sentence frame and situational context in children's perception of novel words denoting emotions. In Study 1 (N=135, ages 3-5) children viewed puppet conversations that used a novel word in one of three sentence frames that varied in how much they restricted the semantics of the word (i.e., least restrictive: is binty; moderately restrictive: feels binty; most restrictive: feels binty about something). In a subsequent picture pointing task children selected the cartoon image (depicting an emotion, physical state or action) they believed matched the meaning of the word. Older children were more likely to choose an emotion or physical state image, and sentence frame marginally impacted image choice. In Study 2 (N=113, age 3-5), we added situational context through short cartoons depicting emotional scenarios. Children were introduced to a novel word in one of three sentence frames as in Study 1. Emotion images were chosen more with age and more restrictive sentence frames. In an exploratory archival analysis we examined common sentence frames used with emotion words in adult-child discourse from 12 children, focusing on years 2 and 3. Interestingly, we found that the most common sentence frame used by adults at this time was be verbs (is, am) and the least was the verb feel. We are currently expanding the analysis to include data through age 5 and to examine the frequency of non-emotion words with various sentence frames, especially that of feel, to assess the cue reliability of sentence frames for emotion word acquisition in daily life and discourse.

3-D-75 Parent-child conversations: Children's figurative language understanding and perceptual representation

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Introduction: Verbal irony is nonliteral language that makes the discrepancy between expectations and reality salient. Children as young as five are able to detect verbal irony (Pexman, 2008). Although past research shows that approximately 8% of everyday adults' conversations consist of ironic utterances (Gibbs, 2000), little research exists on the use of irony during the first few years of parental child-directed speech. To address this gap in the literature on indirect speech, this we investigated the possible links between young children's figurative language comprehension, and their ability to match the meaning to the representation of the world (Searle, 1979). That is, we studied the linguistic meaning of mothers' utterances in terms of whether or not the utterances could be interpreted by the child either in reference to either perceptually available objects or situations such as the child's play behavior,

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or interpreted as an object/situation that was not perceptually available or abstract such as the behaviour of the mothers' partner who was absent at the time of the utterance. Method: This study analyzed data from the Providence Corpus of CHILDES (Demuth et al., 2006; MacWhiney, 2007). The chosen corpus contained longitudinal, video-recorded data of six monolingual English-speaking children aged 2;10-3;05 during spontaneous interactions with their mothers at home. We used the data of five of the six children (one of them was diagnosed with ASD). Fifty hours of speech were randomly chosen from 364 hours of videos. Ironic utterances were identified in the videos and then assessed by competent judges to ensure that they met the criteria for verbal irony (Dyner, 2014). Results: Gleaned from 22 examples, approximately 77, or 30% of sentences included irony with visible reference points for children and about 22, or 70% did not. Conclusions: We found that when using ironic comments, mothers were more likely to use irony if their utterances included references that were abstract, as compared to references that were visible for the child. The present study supports past findings on language development and child-directed language that show children acquire words that are labels for non-abstract, tangible concepts earlier, and appear more frequently in parent-child interactions with very young children as compared to labels that describe abstract concepts.

3-D-76 Labels, but not maps, help young children reason about midpoint

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Understanding the midpoint relation is an important milestone that lays the foundation for more advanced concepts like bisector, half and balance. Yet, it is a challenging spatial relation for young children to understand. Prior work suggests that having a way to describe this complex relation - such as the word "middle" - may support children's ability to reason about it (Ankowski, Thom, Sandhofer, & Blaisdell, 2012; Simms & Gentner, 2019). In the present study, we gave 3- and 4-year-olds a challenging midpoint search task, in which they had to infer that a treasure would always be hidden exactly in the middle of two landmarks (as in Simms & Gentner, 2019). We asked whether providing the label "middle" would help children succeed. In addition, we compared providing the "middle" label to providing a more iconic visual cue - showing the child the location on a map. Our findings suggest that although the map provided more detailed spatial information, 3- and 4-year-olds showed greater benefits from the more abstract label. Specifically, children who heard "middle" during the task more accurately searched at the midpoint, and made fewer searches outside the landmarks (which indicate a failure to encode even the qualitative, between aspect of midpoint), than children who did not; the same was not true of children who saw a map. This work helps clarify the mechanisms by which labels support relational reasoning (e.g., Gentner, 2010, 2016).

3-D-77 How many observations is one generic worth?

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Generic language (e.g., "Birds fly") conveys generalizations about categories and is a simple and ubiquitous way of learning beyond direct experience. The meaning, and hence the belief-updating capacity, of generic language is hard to specify however (e.g., penguins don't fly), owing to extreme forms of content and context-sensitivity. Tessler & Goodman (2019) proposed that generics are a kind of vague quantifier (a la "some", "most") which operate over richly structured prior knowledge. Their computational model is mathematically equivalent to simple Bayesian belief-updating based on a single

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positive example. This rather surprising mathematical connection between learning from generic language and learning from observations suggests a developmental mechanism for meaning acquisition, namely: semantics can co-opt more basic mechanisms of belief-updating from observations. Relatedly, Csibra & Shamsuddeen (2015) argue that generics are an inherently non-verbal but pedagogical phenomenon, which can be understood by prelinguistic infants via intentional reference to a member of a kind. In a quantitative study with adults, using a diverse set of stimuli covering a range of prior beliefs, we compare the belief-updating capacity of generic language to that of single observations, both presented pedagogically and incidentally. We find that generics convey stronger generalizations than single observations even when presented pedagogically (which we operationalize in two distinct ways), raising new questions about the contextual parameters that would support learning generic-like generalizations from pedagogical demonstrations in infancy and early childhood.

3-D-78 Relations between motor and language development in typically-developing children

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Recent research has adopted the theory of embodied cognition to demonstrate that fine and gross motor skills are linked with language abilities in children. Proponents of this theoretical perspective assert that cognition must be understood in terms of the interrelationships between the various domains of development. Additional research exploring whether the relation between motor and language development persists longitudinally is needed to inform the optimal timing of intervention programs. Our objective is to investigate whether fine and gross motor skills at 12 months are related to language abilities at 24 months and 5 years. Preliminary results indicate that fine motor skills are related to language abilities at 24 months ($r = .152$, $p < .001$) and 5 years ($r = .151$, $p < .001$). Gross motor skills are related to language abilities at 24 months ($r = .160$, $p < .001$) and 5 years ($r = .107$, $p = .002$). Future analyses will investigate whether language abilities at 24 months mediates the relation between fine and gross motor skills at 12 months and language abilities at 5 years.

3-D-79 The impact of a bilingual home environment on language and attention networks: Preliminary evidence from toddlers born pre-term

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Children raised in bilingual homes reach language milestones at approximately the same age as children raised in monolingual homes, despite the often "noisier" language input they receive. Some research suggests that in order to overcome their noisy language environment, the bilingual brain maintains neural plasticity for an extended period of time, and bilingual children increase their perceptual attention toward language stimuli. Does this extended neural plasticity and increased attention toward language stimuli change the connections between language and attentional networks in the developing brain? Here we present pilot data comparing bilingual and monolingual toddlers who were born preterm. There is growing awareness that preterm birth might also increase neural plasticity such that prematurity exaggerates environmental effects on the brain. Results indicate that bilingual toddlers had greater right medial superior frontal gyrus volume and stronger functional connectivity between this region and the right anterior cingulate cortex, insula, and right hemisphere language regions than monolingual toddlers, suggesting that a bilingual environment may increase connections between language and attention networks.

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3-D-80 Speaker race influences infants' word retention

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Do infants selectively learn better from familiar race speakers? Twenty-month-olds were taught four new words, two from a familiar race speaker (e.g., 'mito' and 'dax') and two from an unfamiliar race speaker (e.g., 'tipu' and 'nim') in ostensive labelling videos. They were then immediately tested on their retention of these newly learned words. They saw test arrays of four objects, the to-be-labelled target object (e.g., the object labelled 'nim'), a novel object (e.g., abacus), a familiar object (e.g., shoe), and previously seen distractor (e.g., the object labelled 'dax'). Both monolingual (N=24) and bilingual (N=19) infants showed stronger recognition for the words taught by the familiar race speaker ($ps = .021$ and $.060$ respectively), and tests against chance revealed significant looking to the target for only words taught by the familiar race speaker ($ps = .016$ and $.054$). Infants more readily learn words from individuals who are members of their linguistic community.

3-D-81 Essentially blocked: The role of structural context in blocking essentialism

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Language provides important cues for children's developing representations of categories. Some types of language, such as generic language ("Dogs bark"), can promote psychological essentialism (essentializing the category DOG). Psychological essentialism is the belief that certain categories map onto real distinctions in the world, and that such categories possess "essences" that causally produce innately determined and stable properties across category members. Recently, formal explanations ("Fido barks because Fido is a dog") have been proposed as a linguistic cue for essentialism, since they often yield essentialist interpretations. However, formal explanations may be more ambiguous than previously thought. When using gender categories as a case study, preliminary data from children and adults suggest that formal explanations could yield either an essentialist interpretation, or a social-structural interpretation, depending on the available context. As a result, contextual information could block an essentialist interpretation of a formal explanation, and promote a social-structural interpretation instead.

E – Psychological and moral reasoning

3-E-82 Preschoolers' evaluations of minimal givers

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Adults and children expect resources that are acquired as a windfall gain to be distributed equally (Shure, 1968). Research largely focuses on children's concerns for windfall gains (e.g., Chernyak & Sobel, 2015), yet there are different social norms for owned items. People are not expected to offer half of their bank account, in fact, giving just a little is considered generous. The current study seeks to examine children's evaluations of agents (who are either wealthy or not) who give a minimal amount of owned resources. We tested preschoolers' (N=84, Mean = 52.35 months, range=45-59 months) selective trust in and spontaneous sharing with 3 agents. In the Rich Condition, all agents owned an excessive amount (i.e., 150 stickers each); in the Poor Condition, all agents owned a small amount (i.e., 4 stickers each). Across conditions, children observed one agent give 0, one agent give 1, and one agent give 2 stickers.

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Then children played a finding game with 2 agents at a time, who each gave advice about the location of the hidden prize (e.g., agent who gave 0 versus agent who gave 1 sticker). We measured both children's selective trust between the agents in 3 trials and their own spontaneous sharing of 3 earned stickers. Preliminary results indicate children are more likely to share their own stickers in the Poor Condition, $F(1, 84) = 4.723, p = .043$. In both conditions, children were also more likely to trust the agent who allocated more stickers significantly from chance, $t(83) = 2.805, p = .006$, with a marginal effect of Condition. These results indicate that children evaluate proportional giving of owned resources differently, depending on the wealth of the donor.

3-E-83 Should I stay or should I go? Three-year-olds' sensitivity to appropriate motives to break a commitment

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Commitments create obligations, but the precise scope of commitments can never fully be made explicit. For instance, we expect someone to be released from her commitment anytime this conflicts with a weightier moral consideration (Shpall, 2014). Previous research shows that three-year-olds understand the obligations entailed by joint commitments (Gräfenhain et al., 2009), and they distinguish between instances in which a partner fails to make a contribution intentionally or for other reasons (Kachel et al., 2017). But can they assess the legitimacy of motives leading agents to intentionally break commitments? To probe this, we manipulate the motives that lead a partner to break a commitment. Three-year-olds play a game together with a puppet who suddenly interrupts this joint activity either because (a) she is lured away to play another tempting game; or (b) she assists another agent in distress. We measure whether children release the partner by scoring their verbal reactions on a Release Scale of -1, 1; where -1 means denying release, and 1 means giving release. Data collection ($N = 60$) is in progress. Pilot data ($N = 15$) show that children release the partner more often when the partner is faced with a conflicting moral duty ($M = 0.5$), while manifesting signs of protest (i.e. denying the release) when the partner is lured away by another tempting game ($M = -0.67$). This suggests that three-year-old children make appropriate normative evaluations of the scope of commitments.

3-E-84 Do toddlers distinguish between dutiful and virtuous helpers?

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Members of a social group are expected to help and support each other in the process of sustaining the cohesion of their group. Do young children construe helping ingroup members as obligatory, but helping outgroup members as optional? To find out, we showed 2.5-year-old toddlers a protagonist who was helped in turn by an ingroup and an outgroup member. If toddlers evaluated the outgroup helper (who went beyond what was morally expected and gave evidence of virtue) more positively than the ingroup helper (who might be acting solely out of duty), it would suggest that they construed ingroup support as a moral obligation. Toddlers heard a story, accompanied by pictures, about two groups, Tyboos and Modies. A protagonist from one group (e.g., a Modi) went to a store and bought a basket of apples. On his way home, he dropped an apple, at two different times. One apple was returned to the protagonist by an ingroup member, and the other was returned by an outgroup member. Next, toddlers received an implicit social-preference test in which they saw pictures of the two helpers, and an explicit test in which they were asked which helper they liked better. In both tests, toddlers preferred the outgroup helper.

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This effect was eliminated when the protagonist never dropped apples and was simply greeted by the ingroup and outgroup members. Toddlers thus evaluated outgroup helpers more positively than ingroup helpers, suggesting that they appreciate both obligatory and virtuous actions.

3-E-85 Moral balancing judgements in children

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The theory of moral balance suggests that an individual's morally relevant actions are not considered in isolation. Instead, a history of moral behaviour may encourage observers to be less harsh when judging transgressions, while a history of immoral behaviour may encourage harsher judgements (Effron & Monin, 2010). While previous research by Nisan and Horenczyk (1990) has demonstrated that children may make this pattern of judgements as young as 13, it is unclear whether younger children are also able to make balancing judgements. Therefore, the current study adapted the methodology used by Nisan and Horenczyk to explore the developmental trajectory of this effect. Across three trials, 140 children aged 4-10 were shown pairs of characters with varying moral histories and asked to make a series of predictions about the likelihood and acceptability of the two children misbehaving. The majority of children expressed a preference for the characters' behaviour to be consistent with their moral histories (eg. for well-behaved children to continue to not misbehave), though a small number appeared to make balancing style judgements. The decision between balancing and consistency may be moderated by individual differences. This demonstrates the powerful, but complex, role that moral behaviour plays in our judgements of others and also motivates future work to take a more nuanced approach to exploring how children utilize the moral behaviour of others in forming value judgements.

3-E-86 Children's judgments of moral and conventional violations committed by individuals with disabilities

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Young children are sensitive to actions that violate moral or conventional norms, and often conceptualize people who commit such violations as unkind and deserving of punishment (Hardecker et al. 2016; Tisak & Turiel, 1988). However, there are many circumstances in which people behave in non-normative ways because they cannot act otherwise—for example, if they possess a disability that prevents them from behaving in accordance with norms or prescriptions. This study was designed to explore whether children (ages 4.00-8.99 years) alter their evaluations of people who commit violations when those persons have disabilities. A total of 77 children were presented four scenarios in which each of three characters (one typically-developing, one who possesses a perceptual disability, and one who possesses a physical disability) commit either a moral or conventional violation. For each scenario, children were asked about each of the three characters' degree of naughtiness and intent. Results indicated that regardless of violation type (moral vs. conventional), younger children (4.00-6.49 years) and older children (6.50-8.99 years) both judged the characters with disabilities as less naughty than characters with no disabilities. In general, older children judged the characters with disabilities as even less naughty than younger children. Thus, even preschool-age children can take into account others' perceptual and physical limitations when evaluating their non-normative behavior, and this tendency increases through early childhood.

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3-E-87 Share my precious: The mechanism of prosocial decision-making in children

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Understanding the mechanism underlying the development of prosocial behavior is essential in order to promote children's social adaptation and well-being. We examined fourteen 5- to 8-year-old children's sharing decision-making using the eye-tracking sharing decision task ("Share My Precious" games) consisting of 80 binary choices of choosing between a prosocial vs. selfish option [allocating four candies to (you, other): e.g., (0, 4) vs. (2, 2), (1, 3) vs. (4, 0), (2, 2) vs. (3, 1); random order]. Children made choices (1) under an empathy inducing condition where they heard a story of a same-aged child who lost a family dog, and (2) under a neutral condition. The results revealed that age significantly predicted the ratio of prosocial choices in the empathy inducing condition ($p=.046$). Additionally, in the empathy inducing condition, the ratio of prosocial choices significantly predicted the ratio of fixation durations and the ratio of numbers of fixations at the prosocial option ($ps<.001$). Children's social competence measured using the Child Behavior Checklist (CBCL) was significantly related to the ratio of fixation durations ($p=.021$) and the ratio of numbers of fixations ($p=.023$) at the prosocial option. Findings suggest that deliberate, controlled cognitive processes would underlie prosocial sharing decisions in 5- to 8-year-old children, and children with higher social competence would be more likely to deliberately consider prosocial sharing choices.

3-E-88 From principles to outcomes: Preschoolers consider attention and precision when judging what's fair

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Children's evaluations of resource distributions depend heavily on outcomes. Here we propose that these judgments are also influenced by whether the distributor intended to be fair. Children watched two teachers distribute cookies between two puppets. In Experiment 1, four- to six-year-olds judged that a teacher who distributed resources attentively was more fair than a teacher who was distracted during distribution, even when both teachers produced identical material outcomes. In Experiment 2, children judged that a teacher who distributed resources by counting was more fair than a teacher who split resources approximately, even when both teachers were attentive and produced identical outcomes. Finally, in Experiment 3, children's judgments reversed when the same teachers from Experiment 2 produced an unfair outcome, with children now condemning the agent who counted. Our findings suggest that children's fairness judgments are sensitive to intentions, and built on intuitions about the role of precision in resource distributions.

3-E-89 Children's responses to economic inequality: A developmental trajectory

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Economic inequality has become an increasing concern in modern developed societies. To date, research has uncovered the psychosocial implications of inequality on adults, finding that unequal environments result in lower prosocial behaviour. However, there has been comparatively little research focussing on how children understand inequality, and how this affects how they treat others. In the current study, we designed a novel economic experiment that safely immerses young children in

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inequality. Four- to nine-year-old children play a series of games against other players where all individuals accrue points over time after colouring in pictures. However, the distribution of these points is either highly equal or unequal. In response to this game, we measured children's altruistic donation behaviour, their resource division behaviour and their fairness perceptions. We further measured children's verbal explanations for each behaviour. While data collection is 95% complete, preliminary results suggest that children's reasoning about the fairness of inequality becomes more complex as they age. Further with age, children redistribute wealth with increasing concern for poorer individuals. Ultimately, the current study aims to establish a safe and effective method for measuring children's responses to economic environments, and paves the way for future research.

3-E-90 Preschoolers' and adults' understanding of novel moral and conventional violations

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Do children learn different kinds of social norms from distinct experiences? Preschoolers and adults watched a video of a novel prohibited action causing pain to a puppet (moral conditions) or a sound from box (conventional conditions). Participants then saw a transgressor puppet, who had either watched the video or not, engage in the prohibited action and evaluated this norm violation across a range of different measures. In study 1, children were more likely to say the target action was wrong in moral than in conventional conditions; adults almost always said the target action was wrong. All age-groups gave different justifications for why the action was wrong in moral (welfare) versus conventional conditions (authority commands or rules) and were more willing to engage in conventional violations themselves. In Study 2, participants made evaluations after an initial transgression and then once more after a second transgression. When the transgressor puppet did not watch the video, most adults thought the puppet knew he was doing something wrong in the moral condition after the first transgression, but rarely attributed such knowledge to the puppet in the conventional condition. Data collection from preschoolers is ongoing. Our findings indicate that preschoolers rapidly construct distinct moral and conventional evaluations about novel actions and promise to provide insight into how people attribute knowledge of new norms to others.

3-E-91 Priming behavioral control enhances preschoolers' generous sharing

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Children do not actively share resources with others although they have knowledge of fairness norms (Smith, Blake, & Harris, 2013). In school-aged children, such discrepancy between fairness understanding and sharing behavior appears to be related to behavioral control (Steinbeis & Over, 2017). However, there is little evidence on whether behavioral control can also explain preschoolers' selfish behaviors when distributing resources. The current research experimentally manipulated behavioral control in preschoolers and examined its effect on their sharing behaviors. Three- to four-year-old children participated in a dictator game. They were randomly assigned to either the behavioral control or neutral story condition. In the behavioral control story, there was an explicit statement that a protagonist actively exercised behavioral control, refraining from eating candies. In the neutral story, there was no such statement: the protagonist simply left the room where candies were located. Then the children were asked how many stickers they want or should share with another child. Preliminary data showed that children in the behavioral control story condition were more willing to share more

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stickers with the recipient than did those in the neutral story condition. This finding suggests that behavioral control plays a critical role in the development of sharing behaviors in preschoolers.

3-E-92 The anthropic teleological bias: Beliefs in human purpose and their implications for moral judgment

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The tendency to endorse teleological (purpose-based) explanations of living and non-living things develops early and occurs cross-culturally. But it is unclear how the bias affects children's and adults' view of a specific category of living things: humans. The present study explored whether participants (mean age=18.7, N=109) show a bias for endorsing teleological explanations for human existence, whether this bias leads to harsher moral judgments of individuals who fail to fulfill their purpose, and whether participants more harshly judge those who intentionally choose not to fulfill their purpose than those who are unable to fulfill it. We found evidence that adults think about humans as existing for a purpose, particularly that humans exist to reproduce and carry on the species. The correlation between this bias and moral judgment is currently being investigated in a follow-up. Participants were also sensitive to whether individuals chose not to fulfill their purpose, judging these cases more harshly than when they simply were unable to fulfill it; however, individuals who were unable to fulfill a purpose were still judged to some degree. This study supports previous research on the teleological bias but is the first to our knowledge showing that adults explicitly endorse belief in human purpose. Future research will explore whether children's teleological bias affects their reasoning about human purpose and moral judgment in the same way as adults.

3-E-93 Non-binding commitment and cooperation in children

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Communication is a powerful tool for promoting cooperation, and is considered as one of the most important solutions to social dilemmas. One important aspect of communication is whether partners can communicate their intent to cooperate in these situations. Indeed, adults cooperate more after they make a non-binding commitment to cooperate than when they are not allowed to communicate their intention to their partners. Despite its importance in promoting cooperation in adults, we know little about whether communication plays a similar role in promoting cooperation in children. In the current study, we tested whether non-binding commitment promotes cooperative behavior in children. Six- to nine-year-old children played with a partner in a simultaneous version of the Prisoner's Dilemma Game. In the communication condition, they could communicate their intended decision prior their actual choice, while in the silent condition, they were not able to communicate. Overall, communication did not influence children's cooperative behavior in the game. However, in the communication condition but not in the silent condition, children's behavior was contingent on their previous behavior: children who cooperated in previous trials were more likely to cooperate in subsequent trials, while those who defected previously were more likely to defect in the future. These findings suggest that children use non-binding commitment as an honest signal of their intention to cooperate and, more broadly, add to our emerging understanding of the ways in which children begin to solve social dilemmas.

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3-E-94 Developmental changes in the perceived moral standing of robots

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Artificial intelligence is becoming integrated into everyday life. There may come a time when humans owe artificial minds moral consideration. To date, however, we have little understanding of how children or adults think about the moral status of artificial life. Here, we investigate these evaluations in children and adults. We find that children (Study 1, N = 125) grant both humans and robots with heightened mental life and moral standing, over an anthropomorphized control (i.e., a toy bear). Adults, however, ascribe lesser mental life to robots and deny their susceptibility to harm (Study 2, N = 150). This developmental discrepancy appears driven by younger children's willingness to assign experiential mental capacities to robots (e.g., being capable of experiencing hunger, fear, happiness). Older children and adults, however, seem to attribute robots with exclusively higher-order mental abilities. These data suggest that, with age, we limit our circles of moral concern; we become less likely to think that non-humans--such as robots--have moral standing. This bears on ongoing debates concerning motivated reasoning, dehumanization, and emerging attitudes about artificial life.

3-E-95 The multidimensionality of infant prosocial behavior: An investigation of type, target, and emergence

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Little is known about infants' selectivity in helping and sharing and whether these behaviors emerge due to socialization influences or natural tendencies. This study experimentally examined 230 11-to-26-month-old infants' helping and sharing towards caregivers and strangers in the home and explored possible socialization and temperamental mechanisms. A mixed model with significant effects of type, target, and a Type X Target interaction (all $p < .001$) revealed that infants engaged in more instrumental helping ($M = 3.37$) than sharing ($M = 2.23$), $t(144) = 7.85$, $p < .001$, and were overall more prosocial towards caregivers ($M = 3.22$) than strangers ($M = 2.38$), $t(145) = 5.80$, $p < .001$. Additionally, infants helped caregivers ($M = 4.09$) more than strangers ($M = 2.65$), $t(310) = 7.49$, $p < .001$, but shared with caregivers ($M = 2.35$) and strangers ($M = 2.11$) equally, $t(156) = 1.00$, $p = .32$. Separate multivariate analyses of infant helping and sharing revealed that help towards caregivers was predicted by maternal empathic concern, $B = .23$, $p = .04$, whereas help towards strangers was predicted by infant productive vocabulary, $B = .38$, $p < .001$. Also, sharing with either target was predicted by productive vocabulary, $B = .20$, $p = .02$. Interestingly, child temperament did not predict helping or sharing toward either target. These findings support a multidimensional approach to prosocial behavior and have important implications for the emergence of infant helping and sharing.

3-E-96 The impact of socioeconomic status on parents' use of mental-state talk with their infants

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Parents' use of mental-state terms - words referring to desires, thoughts, and feelings - positively predicts their children's mental-state vocabulary, emotion understanding, and theory of mind (Taumoepeau & Ruffman, 2016). Research suggests that parents initially talk about desires and

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emotions, gradually using more cognition terms (i.e. think, know) as their children get older (Taumoepeau & Ruffman, 2008). This pattern is thought to scaffold socio-cognitive development in early childhood. However, this research has focused largely on higher income parents. The present study sought to clarify the nature of mental-state talk in parents of lower socioeconomic status (SES) and whether these parents exhibited an age-based transition in the focus of their mental-state talk. A socioeconomically diverse sample of parents read a picture-book with their infants (19 and 24 months old). Parent talk was coded for the percentage of utterances containing emotion, desire, or cognition terms. At 19 months, parents used more emotion ($M = .37$) than cognition ($M = .02$) terms, and this did not vary by SES ($F < 1$). At 24 months, high SES parents decreased use of emotion terms ($M = .24$) and increased use of cognition terms ($M = .10$; $ps < .05$). However, low SES parents continued to use high rates of emotion terms ($M = .33$) and few cognition terms ($M = .03$). This suggests that SES affects parent mental-state talk in ways that may impact children's socio-cognitive development.

3-E-97 Reducing children's group bias: The role of common ground

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Children show essentialism in forming in-group and out-group attitudes, assigning common characteristics to members of a group and evaluating in-group members more positively than out-group members (Gelman, 2004; Dunham, 2018). This study explored whether finding common ground with out-group individuals can mitigate group bias. Specifically, we investigated how children's group preferences may be influenced by: (1) connecting to individual group members on a personal level, and (2) the context in which the groups are presented. Preschool children ($N = 88$, age range = 3.43 to 5.95 years, 50% girls) were introduced to paper characters, some of whom belonged to the same arbitrary group as the child (in-group) and some of whom belonged to a different group (out-group). We varied the type of information about the groups in a two-by-two factorial design. In one between-subjects manipulation, children either received neutral information about the characters (Baseline condition) or were told that some characters across groups shared the child's preferences (Similarity condition). In another between-subjects manipulation, the two groups were presented either in a competitive context (Competition condition) or in a neutral context (No-competition condition). Children's attitudes toward characters from both groups were assessed in a series of measures. We found differential effects of similarity and competition. When asked whom they liked more and with whom they would prefer to play, children in the Similarity condition were significantly more likely to choose out-group individuals over in-group individuals than were children in the Baseline condition. When asked to award a prize to one of the groups, children in the No-competition condition were more likely to give the prize to the out-group than were children in the Competition condition. These results demonstrate the role of context and personal experience in the formation of children's group attitudes, and suggest that finding common ground with individual group members can help reduce group bias.

F – Social cognition and social learning

3-F-98 Identities and essentialism: Do multiracial and transgender children essentialize race and gender less than monoracial cisgender children?

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Studying children with diverse gender and racial identities is important as it can help us understand how identity and experience with race and gender relate to how children view those categories in the world. Due to their lived experiences in groups that violate essentialist beliefs (e.g., that categories are distinct, innate, etc), multiracial and transgender children may hold different beliefs about gender and race than monoracial cisgender children. To test this question, 6 to 11-year-old monoracial cisgender children ($n=29$), monoracial transgender children ($n=18$), and multiracial cisgender children ($n=30$) completed a race and gender essentialism task (based off Rhodes & Gelman, 2009). Interestingly, preliminary results suggest that, across the three participant groups ($N=77$), children essentialize race, $F(1, 75) = 0.25$, $p = 0.62$, $\eta^2 < 0.01$, and gender, $F(1, 74) = 0.10$, $p = 0.75$, $\eta^2 < 0.01$, to a similar degree. If results continue to show that all groups essentialize to a similar degree, this would suggest that one's own identity and experience is not related to the degree to which children endorse race and gender essentialist thinking.

3-F-99 In friends we trust: The influence of friendship on selective learning

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Friendship is important to children, and even preschoolers understand the core features of what it means to be friends (Afshordi, 2019; Liberman & Shaw, 2019). Older children also recognize the role of bias in decision-making, such as a judging a contest (Mills & Grant, 2009). However, it is unclear whether preschoolers understand the more nuanced form of bias that happens in the context of friendship: People are often inclined to believe their friends. To answer this, we showed adults ($N=65$) and children ($N=60$ 4- and 5-year-olds) videos that depicted 3 characters: the protagonist, Maya, her best friend, and a stranger. Across between-subjects conditions, the friend either provided correct labels (Baseline), or incorrect ones (Inaccuracy), contrasting with a stranger, who provided only correct labels. On half the test trials, participants made their own Ask and Endorse decisions, and on the other half, they were asked to predict Maya's decisions. We found that children and adults gave divergent responses. Adults anticipated that Maya would make different decisions than they did ($p = .003$), and that she would believe her friend both at Baseline (80%), and when the friend was inaccurate (67%), while they themselves did not favor the friend in either condition (52% vs. 45%). In contrast, children prioritized accuracy ($p = .0008$). Their response pattern was similar for themselves and Maya in both conditions. When the friend had been inaccurate, they mistrusted her (37%) and expected Maya to do so too (35%). Thus, by age 5, children have yet to shift from an accuracy-based view of testimonial trust to a nuanced one that takes relationships into account.

3-F-100 Do you know what I know? Children's reasoning about cultural common ground

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When communicating with a stranger, determining what is common ground can be challenging. Mature communicators can predict shared knowledge by assessing the social groups both communicators are part of ('cultural common ground'; Isaacs & Clark, 1987). The current study assesses the types of knowledge children think are shared as a function of being from the same social groups. Thirty-eight 3- to 6-year-old children were shown photos of one 'similar' and one 'dissimilar' child, with similarity manipulated by: living in the same/different city, knowing about the same/different show, or having the same/different sticker. Participants were then asked about three different types of knowledge: cultural knowledge; (e.g., where a familiar museum is), novel cultural knowledge (e.g., where a novel museum

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is), and general knowledge (e.g., what colour grass is). Similarity type influenced participants' responding ($p=.004$) with participants using location information to inform their knowledge judgements more often than when they were similar in sticker ($p=.023$) or TV show ($p=.048$). Participants indicated that both children would know general knowledge at above chance level ($p=.004$) and with no influence of similarity type ($p>.05$). These results support the idea that children use relevant (and ignore irrelevant) cues of group membership when reasoning about cultural common ground. Children are also sensitive to the specificity of these cues, as they did not use similarity to inform their predictions of general knowledge.

3-F-101 What predicts pro-White bias in resource allocations?

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Children show pro-White racial biases across domains; even racial minority children often display attitudes (Clark & Clark, 1947) and make economic decisions (Shutts et al., 2015) that favor White targets. However, pro-White attitudes do not predict White-biased economic decision-making (Shutts et al., 2015). This pre-registered study examined whether 4 -6-year-old children's (M age = 5.4 yrs; $n = 97$; 38% male) race-based resource allocation instead stems from expectations of reciprocity (i.e., sharing more with those expected to share with you), or by children's tendency to use race to predict wealth (i.e., expecting White people to have more wealth than Black people). In a dictator game task, children actually shared fewer resources when expectations of reciprocity were high; this was true for allocation decisions to both Black, $\beta = -.86$, $p = .038$; and White, $\beta = -1.51$, $p < .001$, targets (Fig. 1). Although children overall used race to predict wealth (61% of children responded in a stereotypical fashion), awareness of this stereotype was unrelated to the number of resources allocated to White or Black targets, all $ps > .10$. These findings suggest that young children's race-based economic decision-making seems to be divorced from their attitudes and stereotypes, but are related to expectations of reciprocity, albeit in an unexpected manner.

3-F-102 Longitudinal relations between infants' emerging social-cognitive capacities and their later theory of mind

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Research suggests that there is continuity in social cognition from infancy through early childhood, including links between preschoolers' theory of mind (ToM) and infants' triadic engagement, point following, and intentional action processing. However, existing studies are limited by small sample sizes, restricted infant measures, and narrow ToM assessments. The current study aimed to provide a more comprehensive investigation of relations between infant social cognition and preschool ToM by (1) utilizing a robust sample size ($n = 118$); (2) incorporating multiple assessments of infant social cognition (an eye-tracking measure of intention understanding; observed measures of triadic interaction, as well as responding to and initiating joint attention); and (3) using a broad ToM assessment designed to capture individual differences across multiple domains (e.g., understanding belief, desire, knowledge; Children's Social Understanding Scale). Results showed that there were no significant relations between ToM and infants' intentional action understanding or triadic interaction. However, infants who were more likely to follow gaze and initiate joint attention at Time 1 (M = 9.4 months) showed more advanced ToM abilities at Time 2 (M = 40.4 months)—especially in the area of belief understanding. These results

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strengthen and extend existing evidence suggesting that the origins of ToM lie in social-cognitive capacities established in infancy.

3-F-103 Children connect feelings of ownership with taking care of un-owned objects

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People sometimes feel as if they own items that are not really theirs. For instance, you may feel as though you own a community garden if you have spent time and effort caring for it. In two experiments, we examined young children understanding of the connection between investing effort and feelings of ownership. In Experiment 1, 92 4-year-olds saw stories where an agent cared for an item they did not own. For example, in one story, a child took care of their class goldfish. After each story, children were asked three questions about whether: 1) the agent felt like they owned the item; 2) the agent believed they owned it; and 3) the agent actually owned it. We found a main effect of question, $p < .001$, and an interaction between question and age-in-months, $p < .001$. Children were more likely to judge the agent had feelings of ownership than false beliefs of ownership or actual ownership, and these differences increased with age. In Experiment 2, we tested 62 3-4-year-olds and found that they anticipated that caring for an unowned item influences happiness. Children predicted an agent would be happier after an item thrived (e.g., class goldfish grew larger) if the agent had taken care of the item, rather than a different one, $p = .035$. Together, the findings show that children distinguish feelings of ownership from actual ownership and from false beliefs of ownership. The findings also suggest children grasp how antecedents of these feelings link with other emotions.

3-F-104 Requesting help from a supernatural deity: Children's folk reasoning and problem-solving

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During early-to-middle childhood, folk reasoning about objects, people, and living things becomes increasingly sophisticated (Wellman & Gelman, 1992). This study examined the relationship between children's folk reasoning and the types of solutions they request for help with solving problems. 128 ethnically and religiously diverse children participated ($M_{age} = 5.96$, $SD = .739$; 67.2% female). Theory-of-mind (ToM) was measured with a background knowledge task, and children indicated if they should ask God for a biological (e.g., grow taller), psychological (e.g., want something), or physical (e.g., toy fixed) solution to two problems: one physical and one psychological. Children chose the physical solution first for the physical problem (61.7%) and chose the psychological for the psychological problem (54.4%). Being older ($r = -.276$, $p < .01$) and having better ToM ($r = -.257$, $p < .01$) were associated with choosing the physical solution to the physical problem but were not significantly related to choosing psychological solutions for the psychological problem (see Table 1). These findings suggest that, even when the agent being asked for help is supernatural and unobservable, young children choose realistic solutions based on the domain of the problem. Our poster will discuss the implications of these findings.

3-F-105 Behavioral coding of children's engagement in a group musical setting

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Recent research has highlighted musical engagement as a potential scaffold for social engagement in children with autism spectrum disorder (Skaggs, Lense, & Clayton, 2017), but little is known about the way typically developing children's engagement varies across different types of music-making activities and across repeated presentations of the same stimulus. There is evidence that rhythm-only music (without melody) is as engaging for infants as more complex musical stimuli (Zentner & Eerola, 2010). The current study investigated typically developing children's engagement - defined operationally as gaze orientation, gesture participation, and vocalization - across three types of classroom-based learning activities in pre-kindergarteners. The three instructional conditions were nonmusical, rhythm + spoken word, and rhythm + sung melody. Using behavioral coding from video, data from 2 classrooms participating in all 3 conditions on 2 dates were analyzed ($N = 36$). Gaze orientation toward the instruction increased in both musical conditions (rhythm + spoken word, and rhythm + sung melody) over time, while vocalization increased over time only in the rhythm + spoken word condition. Gesture participation did not differ across conditions or time. The results suggest that using rhythm + sung melody in the context of teacher-led instruction may not offer benefits for engagement beyond that of rhythm + spoken word, which could be helpful to educators who wish to integrate rhythmic instruction but lack singing experience. Additionally, the increase in engagement over time for rhythm + spoken word suggests that rhythm-only instruction may facilitate increasing vocal participation.

3-F-106 Rethinking disgust across the lifespan: Food as a key disgust elicitor

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Reacting with disgust towards foods with no signs of decay or uncleanness has been considered an immature form of disgust. However, it is unknown whether this conception actually reflects experiences of disgust across the lifespan. To examine the extent to which disliked foods are an important and understudied aspect of disgust, we recruited 3- to 12-year-old children at a museum ($n = 102$) and an online sample of adults ($n = 120$) and asked them open-ended questions about what they consider disgusting. One group of participants was asked "what is disgusting?", one group was asked "what is gross?", and one group was asked what a disgust face was reacting to. Coders reliably categorized responses as general (e.g., "something disgusting"), animal (e.g., an animal name), core disgust (e.g., bodily products, rotting), sociomoral (e.g., reactions to an event), foods (e.g., broccoli, peaches), and other (e.g., non-disgust emotions, responses that did not fit into other categories). All 5 categories differed from food: Core elicitors were more frequent ($b = 0.61$, $p < .001$) and all other elicitors were less frequent (general: $b = -1.67$, $SE = 0.17$, $z = -9.9$, $p < .001$; animal: $b = -1.82$, $SE = 0.18$, $z = -10.13$, $p < .001$; sociomoral: $b = -1.17$, $SE = 0.14$, $z = -8.48$, $p < .001$; other: $b = -0.41$, $SE = 0.11$, $z = -3.82$, $p < .001$). Gender and condition were not significant predictors. These findings suggest that disliked food may be an important aspect of the disgust system across the lifespan.

3-F-107 Spontaneous level-2 perspective taking in novice symbol learners

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Level-2 perspective taking (L2PT), the ability to compute how a scene looks from another perspective has been found to emerge in implicit task contexts in adults. When judging what number they see on the screen, the presence of a co-actor, observing stimuli from the opposite perspective hinders performance for asymmetric numbers. We present here the first evidence that school-aged (8- to 9.5-

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year-old) children demonstrate adult-like perspective interference in the number-verification task. Note however, that the level of children's expertise with numbers (while probably less automatized than adults') was uncontrolled and may have varied greatly. Also, as all spontaneous L2PT tasks use over-learned symbols (numbers, letters) as stimuli, it is yet unknown whether such expertise was a precondition of the perspective interference. Thus, in a next experiment, we tested whether L2PT would emerge in adult participants' decisions about newly learned stimuli. Adults studied novel symbol (symmetric and asymmetric) - label pairs and then participated in a verification task with a co-actor. Although their decisions were less efficient for novel symbols than numbers in general, they showed similar spontaneous perspective interference. Data from two experiments indicates that even when the verification decision itself imposes higher cognitive demands (due to less experience with the target symbol because of age or novelty of symbols) L2PT remains intact.

3-F-108 Across multiple dimensions of status, children prefer high-status people but give more to low-status people

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Social status is ubiquitous and even young children are likely exposed to people who differ in social status. In this work we examine if children use others' social status to inform their preferences and giving behavior. Across three experiments, we investigated whether 4-, 5-, and 6-year-old children (N=192) recognize different dimensions of status (wealth, physical dominance, decision making power, and prestige), have preferences based on these status dimensions, and give based on these status dimensions. In all experiments, children heard 16 stories about one high-status character and one low-status character and then were asked either who was in charge, who they liked best, or who they wanted to give erasers to. In Experiment 1, we found that children readily identified high status individuals as "in charge" compared to chance responding, $t(47) = 7.92$, $p < .001$, $d = 1.14$ suggesting that children recognize social status differences. In a subsequent experiment, we found that children preferred high-status individuals when asked who they liked best, $t(47) = 5.77$, $p < .001$, $d = 0.83$ suggesting that children may already have biases to favor high-status people. However, even though children prefer high-status people, 5- and 6-year-old children actually gave more to low-status people than chance, $t(47) = 4.71$, $p < .001$, $d = 0.62$. The same results held when looking at each dimension of status independently suggesting that these findings are robust across multiple manipulations of status.

3-F-109 18-month-olds understand others' needs

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A great deal of research has investigated when infants and toddlers begin spontaneously helping others. However, less is known about how very young children think helpers should behave - in particular, who they should help. In an eye-tracking study adapted from Köster (2016, 2019), 18-month-olds watched 4 blocks of videos. In each block, two shapes with eyes were shown as able to reach two desired objects, then were impeded by physical obstacles, and then emerged again with one shape impeded and the other free to access its desired object. A helper appeared, and infants' predictive looks to both shapes were recorded. Then, the helper proceeded to assist either the shape in need or the shape who did not need help. 10- and 16-month-olds in Japan and 9- to 18-month-olds in Germany have been shown both to predictively look to the shape in need and look longer to the unexpected event, in which the helper

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assists the shape that does not need help, than to the expected event. In this partial replication, we find that US 18-month-olds ($n = 29$) also predictively look to the shape in need more than to the shape that is not in need ($t(28) = 3.30, p = .003$) but do not look longer to the unexpected event. As in the original studies, we further find that performance on this task is positively, but non-significantly, related to spontaneous behavioral helping, indicating that this task taps a different aspect of social cognition than do behavioral helping assessments.

3-F-110 Coherence in gender cognition

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Cognitive theories of gender development assert that children show consistency between aspects of gender after establishing a sense of gender identity, and research shows some coherence among measures of gender identity/expression. Whether this consistency is observed in transgender children is an open question. To examine this question, we asked transgender children ($N=317$), their siblings ($N=189$), and cisgender controls ($N=316$) to complete measures of gender identity and gender expression. For transgender children only, we also examined the relations between time since transition and gender identity/expression. All three groups showed coherence across measures of gender identity and gender expression. For example, among all three groups, participants who perceived higher similarity to their own vs. the other gender also showed higher preferences for toys that are stereotypically associated with their own gender ($p's < .001$). After controlling for ages of transgender children, no relation was found between the duration they had been treated as their current gender and any of the measures ($-.10 < r's < .06, p's > .11$). Results align with previous research showing marked similarity between the gender cognition of transgender and cisgender children. Furthermore, transgender children's gender identities/expressions show cohesion, regardless of how long ago they have transitioned.

3-F-111 The role of expertise judgments in children's social learning

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Prior research has examined the circumstances and informant traits that inform how children judge sources of information (Corriveau & Harris, 2009; Corriveau et al., 2010; Koenig & Harris, 2005) and has examined how trust in testimony relates to perceived similarity (Schlesinger & Richert, 2019), but negligible work has attempted to manipulate children's trust in an informant, measure learning from that informant, and analyze how that learning persists over time (Corriveau & Harris, 2009). The current study sought to examine how presenting a familiar media character as either clever or clumsy (as unique informant traits) affects children's perceived similarity with that character and learning from that character. Applying lessons from children's perspectives on expertise informants (Lutz & Keil, 2002), it was hypothesized that when the character was presented as clever children would have lower transfer scores, but that when the character was presented as clumsy children would have higher transfer scores. Additionally, it was hypothesized that children who perceived themselves as similar to the character would learn more from that character (Calvert et al., 2007). Fifty-seven 3- to 6-year-olds were visited in their preschool classrooms at 3 different time points. Children watched a video of Sid from Sid the Science Kid solving a problem. After the video, children were tasked with solving an analogically-similar problem. Children were tested for perceived similarity, theory of mind, and character trust (belief

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in Sid's expertise in problem-solving). Results demonstrate that for children who read a story about Sid as clumsy, perceived similarity with Sid was positively correlated with theory of mind scores ($r = .401$, $p = .035$), which in turn were positively correlated with transfer scores ($r = .456$, $p = .015$). The data suggests that children's theory of mind may explain the relationship between transfer and perceived similarity with a character, but in the Clumsy condition only. Conversely, for children to whom Sid was presented as clever, higher memory scores were related to lower transfer scores ($r = -.382$, $p = .041$). Presenting Sid to the participants as either clever or clumsy did not directly affect character trust or learning. Additionally, children's belief in Sid's expertise also did not relate to learning; however, levels of learning remained stable over time, and perceived similarity with Sid may play a role in how children learned from him. The role of social cognition in children's educational media and children's positive views of their own abilities will be discussed as possible mechanisms leading to the observed relationships.

3-F-112 Small groups lead, big groups control: Relative group size and linguistic framing shift perceptions of group social status

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Groups are an intrinsic part of the social world, and social groups can differ in numerical size and status. How do children represent the relation between social group size and status? When considering groups differing in size, two seemingly conflicting possibilities arise: People might perceive either numerically larger or numerically smaller groups as higher in status. Larger groups may seem dominant in that they are more likely to win over smaller groups in conflict situations (e.g., Pun, Birch, & Baron, 2016; 2017). But sometimes smaller groups are higher in status, and there exist cases where small elite groups hold greater status compared to the larger majority. Indeed, at times adults ascribe higher status to numerically smaller groups (Cao & Banaji, 2016). Across three studies (384 3-10-year-olds; 610 adults) we tested the conditions under which children see numerically larger versus smaller groups as conferring status. We demonstrate that with age, children increasingly said smaller groups were higher in status. But across ages, the relative size of the two groups mattered. When groups were closer in numerical size, participants were more likely to say the larger one held status than when groups were more disparate in size. Last, the status referred to (e.g., leader versus in charge) influenced responses. An analysis of participants' explanations supports these findings, with those choosing a smaller group referring to the group's prestige and those choosing a larger group tending to refer to the group's dominance. These results shed light on the developmental trajectories of thinking about prestige and about dominance with respect to social groups.

3-F-113 Young children revise their trust in an informant's claim once they gather counter-evidence, and transfer their revised judgement across tasks

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Children generally show a strong bias to trust an informant's testimony as a reliable source of information. In this study, however, we show that preschool children ($N = 113$; 35-71 months) are able to revise their trust in an informant's claim when it conflicts with later empirical evidence. Children exposed to an unreliable claim shifted from relying on knowledge gained through the informant's testimony to relying on knowledge gained from empirical evidence, when making predictions of a future

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event. This shift in judgment was significantly different from the judgment made by children exposed to a reliable claim ($X^2(1, 89) = 15.04, p < .001$), who for the most part maintained their trust in the informant's claim. This indicates that children are not only passive recipients of information, but that they cautiously evaluate it against other sources when given the chance to do so. Importantly, our experiment also showed that children transfer their inferences regarding the reliability of an informant's claim across tasks. Children exposed to an unreliable informant continued to disregard the informant's claim in a subsequent, similar task, a behavior that was significantly different from children in the reliable condition ($X^2(1, 107) = 16.50, p < .001$). This indicates that children not only revise their trust in the informant's claim for the purpose of solving an ongoing task, but that they hold on to this revised judgment when they are later presented with a similar task.

3-F-114 Children's intuitions on whether power transfers across contexts and agents

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Children are able to infer dominance based on a variety of factors (Gülgöz & Gelman, 2017) and have sophisticated inferences about who they think will win a fight (Pietraszewski & Shaw, 2015). However, it is unclear what broader inferences children make about the dominance hierarchy based on observing someone lose a social conflict: do they infer that the winner is dominant in this interaction, do they infer that winner is dominant over the loser, or do they make broader inferences that the dominant person is generally dominant and the submissive person is generally submissive? Across three studies ($N = 472$), we explore 4- to 10-year-old children's inferences about dominance based on observing the outcomes of a social conflict. Specifically, we tell children about a person who was dominant over another and we asked them if the dominant person will again be dominant when paired with a novel person or context, and whether the submissive person will again be submissive when paired with a novel person or context. We find that children, particularly 7- to 10-year-olds, predict that a dominant person will again be dominant with a new person or context, but they do not necessarily predict that a submissive person will again be submissive. We demonstrate that this is not driven by a simple bias to think that winners will keep winning. We discuss how these results extend research on dominance and speculate on how such inferences may help children to map out their social hierarchy.

3-F-115 Tit for tat? The influence of informants' accuracy and intentionality on children's epistemic inferences and reciprocal information sharing

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Much is known about children's epistemic vigilance when learning from others (Mills, 2013); however, less is known about children's inferences about others, including how children interpret information about multiple traits in social partners. For example, do children make different inferences about others who accidentally versus intentionally mislead them? This study varied both the intentionality (pro- or antisocial) and accuracy (correct or incorrect) of social partners in a search task. Across 3 trials, 3-5-year-olds' ($N = 52$) trust in partners' testimony was measured, as was their willingness to subsequently share true information with their partner when roles were reversed. Overall, children trusted accurate over inaccurate sources ($p < .001$), and shared more with accurate than inaccurate sources ($p < .001$). Intent did not impact children's trust ($p = .603$) or sharing ($p = .242$): children shared information similarly with others who accidentally or intentionally misled them. However, 81% of children identified an

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intentionally misleading partner as "not a good person to listen to," compared to 30% for an accidentally misleading partner. This suggests children are sensitive to others' pro- or antisocial intentions when making inferences about others, even though this information did not impact their own sharing behavior. Thus, children may readily infer others' traits, but not understand the implications of such traits for social interaction.

3-F-116 The effects of target attributes and context on children's imitative fidelity

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Attending to and imitating others' behavior is critical for children to learn both instrumental skills and social conventions (Clegg & Legare, 2016). Given the importance of following social conventions for maintaining ingroup relations (Legare & Nielsen, 2015), children often show higher fidelity imitating conventional behavior than instrumental behavior (Clegg & Legare, 2016). Children typically attend more to high attractive than low attractive individuals (Langlois et al., 2000), thus the attractiveness of a person modeling the behavior could affect children's fidelity of imitation. The goal of the current study is to examine how model attributes and cues of conventionality affect children's imitative fidelity. To explore possible mechanisms underlying imitative fidelity we also assessed children's visual and sustained attention during the study. We predict imitative fidelity and attention will be greater when children observe a high attractive model and interpret her behavior as conventional. For this study, 4- to 5-year-olds ($n = 80$, 39 girls) and 8-9-year-olds ($n = 49$, 26 girls) watched a video of a low or high attractive female model make a necklace. Her behaviors were the same, but instructions varied based on condition. Afterward, children engaged with the objects from the video. Data collection is ongoing. Results will show how model attributes and context affects children's imitation and provide information about the mechanisms that facilitate imitative fidelity.

3-F-117 Parental messages engender Similarity preference in toddlers

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Preschool-age children prefer individuals whom they share traits in common with. By 3 years of age, though not earlier, they rely on explicit messages about similarity from unfamiliar adults to guide their preferences for self-resembling others. Here we assess whether younger children, 20-35-month-old toddlers, attend to adults' messages about share appearance if the adult providing the message is a familiar caregiver. We presented participants ($N = 48$) with a pair of gender-matched dolls. One doll's hair and eye colors matched the participant's, while the other doll's features differed. In the "Explicit condition," Experimenter 1 (E1) labeled each doll's features, and the participant's parent indicated that each doll was either similar to, or different from, the participant. For example, the parent said: "See her hair, it's just like your hair. And, see her eyes, they're just like your eyes." Afterward, E1 exited the room, and a second experimenter, blind to condition, offered participants a choice between the two dolls. The first doll that participants made visually-guided contact with counted as their choice. The "Implicit condition" differed only in that the participants' parents refrained from stating that the dolls' features were similar or different. In the implicit condition toddlers performed at chance, $N=12$ of 24 ($p=1$). However, in the explicit condition, $N=17$ of 24 toddlers selected the self-resembling doll ($p=.032$), binomial test, one-tailed. The two conditions do not differ, ($p=.238$). These results suggest that peer

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selection based on physical traits emerges during the second year of life, and parents' explicit messages about similarity drive this effect.

3-F-118 Pupilometry reveals that motionese benefits infants' processing of dynamic activity

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Infants' detection of structure in dynamic activity - in particular, boundaries at which units of action begin and end - has important downstream implications for cognitive and linguistic development. However, action is complex and unfolds rapidly. Perhaps caregivers' modifications to infant-directed action (e.g., "motionese") systematically facilitates infants' detection of structure within streaming activity. To explore this hypothesis, we measured infants' pupil size (an index of cognitive engagement) as they observed action with and without characteristics of motionese. Infants' pupil dilation response (PDR) to motionese revealed enhanced processing of boundary regions, while these same PDR patterns were not present in response to action lacking such characteristics. Taken together, these findings provide the first demonstration to date that motionese promotes infants' detection of structure as activity unfolds, thereby scaffolding understanding of, and ability to learn from, dynamic, novel activity.

3-F-119 Inferring perspectives from varying emotional pasts: Life history theory of mind

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We evaluated how well 8- to 10-year-olds and adults (planned N=108) selectively use life history information when inferring person-specific mental states. This form of theory of mind involves children's and adults' recognition that people will have diverse reactions to the same person based on their distinct past experiences with that individual. For each trial, an Actor helped or harmed a Target (e.g., Megan). For some trials, the Actor also helped or harmed another Target (e.g., Ella). We included four types: Negative (N: Actor harms Target 1); Positive (P; Actor helps Target 1); Negative-Positive (NP; Actor harms Target 1 and then helps Target 2); Positive-Negative (PN; Actor helps Target 1 and then harms Target 2). Participants reasoned about how one (N, P) or both (NP, PN) of the Targets would react towards the Actor (Targets' emotion to seeing the Actor again; Targets' trait evaluation of the Actor; Targets' prosocial responding toward the Actor). For trials with both Targets, we told participants that the Targets did not know what happened to the other. Participants also reasoned about a naïve person's reactions. Preliminary analyses (current N=70) suggest that participants' privileged life history knowledge erroneously seeps into their judgments about others' perspectives. For example, children and adults expected Megan to respond less positively to the Actor when she had previously helped Megan but harmed Ella (PN, NP) than when the Actor had helped Megan (P) but never interacted with Ella. Also, after learning that an Actor had only helped (P) versus only harmed (N) in the past, participants judged that a naïve person would respond more positively to the Actor.

3-F-120 The influence of representational complexity on children's willingness to cross-classify individuals

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Individuals often hold multiple interrelated social roles, which may make accurate representation of, and appropriate interaction with, others difficult for children. In Experiment 1, we presented children with pairs of roles that varied structurally (e.g., a student-teacher holds roles that are hierarchically structured, while an artist-cook's roles are relatively independent), and then asked children if individuals could simultaneously hold these roles. Younger ($N=33$, $\text{Mage}=4.80$) and older ($N=30$, $\text{Mage}=7.65$) children were reluctant to cross-classify individuals when roles were hierarchically structured. However, older children, but not younger children, were willing to cross-classify individuals with non-hierarchical roles. In Experiment 2, we used a brief training task to scaffold children's understanding of hierarchical structure prior to asking them to cross-classify individuals. Comparing Experiments 1 and 2 revealed a significant interaction between Age Group and Experiment, $F(1,94)=3.89$, $p=.05$. While older children's ($N=18$, $\text{Mage}=5.02$,) willingness to cross-classify individuals was not affected by this manipulation, $p=.56$, younger children ($N=17$, $\text{Mage}=7.91$) cross-classified individuals significantly more often in Experiment 2 than in Experiment 1, $p=.03$. These results suggest that young children's willingness to cross-classify individuals may be influenced by their limited capacity for representing hierarchical structure.

3-F-121 Run away or play with Grandma? How do parents support children's video chat experiences with relatives?

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For families with far-away grandparents, deployed spouses, or travel-heavy work schedules, video chat has become an essential component of staying in touch with loved ones. The current study examined how parents of children ages 16-30 months reported engaging their children in video chat. Most parents reported that video chat holds their child's attention for 5 minutes or less and that children commonly run away from the interaction. During video chats, most parents reported trying to engage children by pointing and asking questions. Parent comments suggest that families are unaware that they can make video chat more interactive and engaging for young children. Results suggest that parents may benefit from evidence-based instruction on how to involve children in video chat interactions in developmentally appropriate ways.

3-F-122 The development of children's status beliefs about race in rural Uganda

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Researchers have documented that children use race as a cue to social status in the United States (Mandalaywala et. al, 2019; Shutts et al., 2016) and in South Africa (Olson et al., 2012). Here we examined whether 5-12-year-old children ($n = 245$) and adults ($n = 30$) in rural Uganda also use race as a cue to status. Using a status ladder task, children and adults considered white targets as higher status than black targets, $p < .001$, and this propensity increased with age, $p = .006$. Children who considered white targets as higher status showed a pro-White bias, $r = .27$, but those who viewed black targets as higher status did not show a pro-Black bias, $r = .01$, a finding with implications for our understanding of the basis of racial bias.

3-F-123 How does child oppositionality impact parent-child conversations about safety?

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Unintentional injury is a leading cause of childhood death and disability in the U.S. Notably, atypically-developing children are at greater risk for unintentional injuries than their typically developing peers. Evidence points to poor executive function and oppositionality, commonly comorbid with ADHD, as driving the increased injury risk in this population. A key question is how to prevent these injuries in both typically- and atypically-developing children. As children gain independence, responsibility for the regulation of risky behaviors must transfer from parents to children. This likely happens in a variety of ways, one of which is parent-child conversations about safety. What these interactions look like while parents and children are engaged in common, yet potentially unsafe activities, such as crossing roads with traffic is unknown. Oppositionality may explain increased risk for injury in children with ADHD above and beyond ADHD-specific symptomology alone. In particular, injury risk arising from oppositionality may be due to a pattern of non-compliance and aggression. By the very nature of the disorder, oppositional children often defy parental rules and guidance, which may lead to an increased likelihood of injury. Although disentangling the contributions of oppositionality over and above ADHD is complicated by common comorbidity among the two, oppositionality may operate as a unique risk factor for injury in children partly by disrupting parent-child conversations about safety. We assessed parent-child conversations in real time while parents and their children (with and without ADHD) were engaged in a simulated risky activity: crossing traffic-filled roads in our pedestrian simulator. Parents and their 8- to 10-year-old children crossed single lane of virtual traffic 24 times. Continuous traffic travelled from left to right at 25 MPH and was comprised of randomly ordered traffic gaps ranging in size from 2.0 s to 5.0 s, with half-second intervals. Audio and video of these interactions were recorded and used for later coding. Measures included use of an anticipatory gap selection strategy by each dyad member (e.g., "let's go after the next one"), the number of gaps suggested and opposed by each dyad member, whether parents made the final crossing decision, whether feedback was provided about the outcome of the crossing, and ADHD symptom severity and oppositionality. We found that oppositionality predicted use of anticipatory gap choice communication in both parents and children. Parents and children were less likely to communicate about the chosen gap prior to its arrival at the crossing line when children had higher levels of parent-rated oppositionality. Further, increased levels of oppositionality were associated with a decrease in feedback about the crossing. Finally, a mediational model using parent-reported child oppositionality as a mediator of the association between parent-reported child ADHD symptomatology and the quality of the parent-child interaction indicated that oppositionality disrupted the overall quality of the interaction. These findings support the idea of oppositionality as a main contributor to increased injury risk and poorer parent-child conversations among this population, as oppositional children may not listen to parental warnings. More generally, this study underscores how individual differences in child oppositionality may impact critical scaffolding processes involved in the transfer of knowledge

3-F-124 Promoting category learning: Guided play in infancy

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Infant category formation is typically studied using visual fixation paradigms in controlled settings, suggesting that attention-directing behaviors, such as labeling and object motion, aid category formation (Gogate et al., 2013; Havy & Waxman, 2016). To our knowledge, no research has explored category formation during "guided play", or child-led and parent supported play (Weisberg et al., 2013).

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We examined 11- to 14-month-old infants' category formation during free play and guided play, predicting that guided play would include the use of various attention-directing behaviors. Preliminary results reveal that the category type impacts infants' learning. When presented with artifactual categories (vehicles, tools) in guided play, infants displayed a significant novelty preference for a different-category exemplar, $t(13)=2.28$, $p = .04$. No such novelty preference was evident when infants were presented with natural categories (fruits, animals), nor after solo free play with any category. Caregivers' use of category labels was associated with infants' novelty preference, $r_s = .74$, $p = .003$. In addition, they used significantly more individual exemplar labels ("apple," "hammer,") with natural category toys ($M = 15.5$) than with artifactual category toys ($M = 7$), $U = 114.50$, $z = -.219$, $p = .005$. We discuss these findings in relation to category learning in naturalistic settings.

3-F-125 Developmental change in implicit and explicit racial biases in Cameroonians

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Although racial bias is widely recognized as a problem with corrosive effects, our efforts to combat it are limited by gaps in our understanding of the nature of these biases. One major gap in our knowledge is that we know little about the developmental course of implicit biases against different outgroups and how these trajectories compare with those of explicit biases. In the present research, we seek to address these questions in Cameroon, which offers unique insights into the development of racial bias (Qian et al., 2016). Cameroonians ranged in age from 4 to 19 years were tested in 3-year intervals. Biases were assessed by comparing attitudes toward Blacks with those toward Chinese and Whites. Implicit pro-Black biases were present at age 4 but reversed into anti-Black biases around age 7. Participants also showed explicit pro-Black biases at age 4 that were no longer evident by age 7. These results suggest that Cameroonian children, like children of other races, initially have pro-own-race biases, but that these biases are short lived. The findings provide evidence for a unique developmental course of racial biases in an understudied part of the world.

3-F-126 Exploration promotes rule-learning: Examining exploratory strategies and self-direction in young children

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Prior literature suggests that exploration prior to instruction enhances rule-learning (Sobel & Somerville, 2010; DeCaro & Rittle-Johnson, 2012). However, it is unknown which particular aspects of exploration enhance rule-learning. To address these questions, we examine the effects of exploratory experience on rule-learning. Further, we test whether children's self-regulatory skills and experiences affect rule-learning. Ninety-nine 6-year-olds learned rules to use keys to unlock locks. Children received instruction either preceded by exploration or instruction without exploration. Following instruction, children generalized unlocking rules to novel locks. Results indicate that exploration prior to instruction improved generalization beyond instruction alone. Further, children's behavioral control abilities enhanced rule-learning. Analyses are ongoing to examine whether children's behavior management experience outside of the lab similarly relates to rule-learning. Fine-grained behavioral coding is also

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ongoing to examine which exploratory behaviors might relate to generalization. Preliminary results suggest that children predominantly attempt to unlock locks during exploration, yet time spent unlocking did not predict generalization. Additional coding will determine whether children's organized behaviors and strategy use during exploration enhance rule learning. Overall, results suggest that exploration and behavioral control skills lead to better rule-learning.

3-F-127 Children distinguish their own gender stereotypes from those of others

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Psychologists have noted a distinction between perceptions of cultural stereotypes and personal endorsement of those stereotypes. Whether children can make this basic distinction--between their own endorsement of stereotypes and their perceptions of others' stereotypes--has not been examined. We assessed children's gender stereotype endorsement, their perceptions of others' stereotyping, and a common correlate of gender stereotyping--gender preferences. We recruited 6-to-11-year-old transgender children (N = 93), cisgender siblings of transgender children (N = 55), and cisgender controls (N = 93). Results indicate that cisgender and transgender children distinguish between their perceptions of others' gender stereotypes and their own endorsement of gender stereotypes. There were no significant differences in transgender and cisgender children's endorsement of gender stereotypes, beliefs of others' stereotypes, or gender-typed preferences. The results provide evidence that children's perceptions of others' beliefs are likely distinct from their personal beliefs.

3-F-128 The development of immigration attitudes: Who has the right to land and resources?

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How do attitudes about immigration develop? People's beliefs about the relative rights of different groups to access land and other resources is a fraught political issue. We assessed the development of children's attitudes about the rights of immigrants versus native peoples. 4-10-year-old children were presented with fictional cartoon vignettes depicting one group that immigrated to another group's island. In a 2x2 between-subjects design, we manipulated 1) the stated context of immigration (fleers who were leaving a resource-poor island versus explorers who were looking for a research-rich island); 2) the degree of cultural assimilation of the immigrants (those who assimilated to the native group's culture versus those who maintained a distinct cultural identity). We measured participants' beliefs about the relative rights of the different groups for land, food, and education resources - as well as their expectations about the solidarity and inter-group relationships of the immigrant and native groups. Understanding the development about beliefs about immigration in varied contexts can inform how people intuitively conceptualize intergroup interactions.

3-F-129 Mentalizing beyond humans: Theory of mind accuracy is unrelated to anthropomorphism

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Humans' tendency to infer others' mental states is thought to be vital to social cognition. Yet people mentalize broadly, attributing mental states to humans, as well as animals, nature, and technology. In

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two studies we explore the relation between accuracy in mentalizing humans and the tendency to mentalize animals, nature, and technology. In study 1, 126 Children 3-10 years (48% female) were given the Individual Differences in Anthropomorphism Questionnaire-Child Form (IDAQ-CF; Severson & Lemm, 2016), a measure of mentalizing animals, nature, and technology. Parents completed the Children's Social Understanding Scale (CSUS; Tahiroglu et al., 2014), a measure of theory of mind accuracy. Controlling for age, we found no relation between CSUS and IDAQ-CF ($r_s = -.02$ to $.11$, $p_s > .22$). In study 2, 50 Children 3-6 years (36% female) were given the IDAQ-CF and the Reading the Mind in the Eyes task (Baron-Cohen et al., 2001), a measure of accuracy in identifying emotional states from pictures of people's eyes. Controlling for age, we found no relation between Eyes task and IDAQ-CF ($r_s = .03$ to $.09$, $p_s > .56$). Thus, anthropomorphism is unrelated to accuracy in mentalizing humans, but may be associated with motivation to mentalize. Indeed, in prior work social interest (akin to motivation) was positively related to anthropomorphism (Tahiroglu & Taylor, 2018). Future work should explore whether the motivation to imagine others' minds drives both the mentalization of humans and non-humans.

3-F-130 Concepts of God: General anthropomorphic tendencies and cultural environmental factors

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Children's anthropomorphic concepts of God are influenced by their parents as well as general developmental trends (Richert, Saide, Lesage, & Shaman, 2017; Severson & Lemm, 2016). But, it is unclear what the relative contribution is of cultural inputs (e.g., religious exposure) and general tendencies to anthropomorphize nonhuman entities. The current study examined this relative contribution. Parent-child dyads ($N = 120$) answered questions about anthropomorphic properties of God for an overall anthropomorphism score. Dyads took the Individual Differences in Anthropomorphism Questionnaire (Severson & Lemm, 2016; Waytz, Cacioppo, & Epley, 2010). Parents provided data on religious exposure. A regression analysis was conducted predicting children's anthropomorphic concept of God. Model 1, including child's age, was significant, $R\text{-squared} = .101$, $F(1, 110) = 12.377$, $p < .001$. Model 2, including children's IDAQ-C scores, improved predictive power significantly, $R\text{-squared change} = .052$, $F(2, 108) = 3.330$, $p = .039$. Model 3, including parents' concept of God, improved predictive power significantly, $R\text{-squared change} = .061$, $F(1, 107) = 8.307$, $p = .005$. Model 4, including children's religious exposure, did not improve predictive power, $R\text{-squared change} = .005$, $F(1, 106) = .742$, $p = .391$. Findings indicate children anthropomorphize God less as they get older. Children's concept of God is related to their general tendency to anthropomorphize. Controlling for this, parents influenced their children's concept, but religious exposure did not. Findings suggest children's concept of God is determined by their tendency to anthropomorphize and their cultural environment, via parents.

3-F-131 Young children's flexibility in group-based reasoning

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We are currently investigating whether children's cognitive flexibility relates to their intergroup attitudes, and shifts in such attitudes after learning that either their ingroup or outgroup members share their preferences. Three- to 6-year-old children (1) are pre-tested in their attitudes towards minimal ingroup and outgroup members, (2) learn that either their ingroup or outgroup members have similar

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preferences (e.g. food, animal) as themselves, and (3) are post-tested in their intergroup attitudes. They also complete tasks that involve cognitive flexibility: (1) a non-social and social Dimensional Change Card Sort (DCCS), where children sort cards according to one dimension first and then according to another (animal and color in non-social, gender and skin color in social), (2) false belief tasks assessing the recognition of people's different perspectives of the same situation, and (3) a metalinguistic awareness task assessing the recognition that words can be similar in different ways (i.e. sound, meaning). Our preliminary data (n = 13, M age = 51 months) suggest that: (1) children demonstrate ingroup favoritism at pre-test with ingroup liking significantly above chance and outgroup liking at chance and (2) children's performance in cognitive tasks do not relate to such initial biases. Moreover, we are finding that children are better at switching between social dimensions than non-social dimensions in the DCCS, at least at a marginally significant level.

3-F-132 Emotion facial recognition training in children with autism spectrum disorder

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Theory of mind skills are developed in typically developing children by age 3 or 4 years, but children with autism spectrum disorders (ASD) have decreased ability to recognize emotion and do not display the same theory of mind skills as their peers. The purpose of the current study was to assess whether facial emotion recognition training would improve emotion recognition and theory of mind skills in children with ASD. Fifteen children with ASD (CA: 6.17-11.58 years) underwent a pre-test assessment, ten sessions of emotion recognition training, and a post-test assessment. The pre-test assessment included the Stanford-Binet Abbreviated Battery IQ, the Peabody Picture Vocabulary Test, 3 measures of emotion recognition, and a theory of mind test battery. The emotion recognition training was completed on iPads using the Let's Face It application. The post-test assessment included the same 3 measures of emotion recognition and the theory of mind test battery. To test the effectiveness of the emotion recognition training on both emotion recognition and theory of mind skills, 4 paired samples t-tests were run between the pre-test and post-test scores. The results of the current study found that emotion recognition training with the Let's Face It application significantly improved emotion recognition skills but did not significantly improve theory of mind skills. All preliminary results from this study will be presented, with feedback welcomed on theory and methodology.

3-F-133 Social status beliefs predict children's preferences for native-accented speakers

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As previous studies have shown that 5-year-old children have preferences for native-accented speakers, less is known on when exactly these attitudes emerge and what may predict these preferences. A possible mechanism could be social status beliefs. 5-year-old children show preferences for individuals associated with high status belongings (Shutts et al., 2016). As foreign-accented individuals, compared to native-accented speakers, are more likely to hold lower status positions (Bradac & Wisegaver, 1984), children who believe native-accented speakers to be higher in status may come to prefer native over foreign-accented speakers. The present study explored whether children's status beliefs are associated with their preferences for native-accented speakers. Results indicate 5 but not 4-year-old children preferred native-accented over foreign-accented speakers. In addition, those who believed native-accented speakers as higher in status showed greater preferences toward native-accented individuals.

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Thus, status awareness may be a contributing factor to children's preferences for native-accented speakers.

3-F-134 Young infants expect an animate's insides to drive its functions

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Research on early biological reasoning suggests that young infants expect a novel animate entity to have insides. But do infants view these insides as playing any role in the entity's ability to function? Building on prior work with preschoolers, we asked whether 8-month-olds would find it unexpected if a novel animate entity could still move on its own after its insides were removed. Exp. 1 sought to make sure that infants would not find cutting open a novel animate entity and removing its insides to be unexpected and distressing. Infants were introduced to two novel animate entities (e.g., a cylinder and a cube) and shown that each was self-propelled and agentic. Next, an experimenter gutted one entity (gutting event) and tilted the other entity left and right (tilting event). Infants looked equally at the two events, suggesting that they detected no violation in the gutting event. Exp. 2 was identical to Exp. 1 except that following the gutting and tilting events, infants saw one of the entities move on its own again. Infants looked significantly longer if they saw the gutted as opposed to the tilted entity move, suggesting that they were puzzled that it could still function (or at least move) without its insides. This effect was eliminated (Exp. 3) if the novel entities gave evidence of self-propulsion but not agency and hence were not categorized as animate. Together, these results suggest that young infants already understand that animates' insides support their function.

3-F-135 Preschoolers do not learn novel causal rules in pretending

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Recent research indicates that pretense can be an effective context for learning novel facts (Hopkins et al., 2015; Sutherland & Friedman, 2012). Theories of pretense representation maintain that pretense must be "quarantined" from real-world knowledge, meaning that there should not necessarily be transfer from pretense contexts to reality. Research on whether children learn from other unreal contexts has been mixed. Some studies show that analogical reasoning is more difficult from fantastical stories (Richert et al., 2009). Others suggest productive vocabulary gains are benefited (Weisberg et al., 2015). Thus, the extent to which children transfer novel information from pretense to reality is an open question. The present study examines this question in another domain, by testing whether preschoolers can learn novel causal rules in pretense. Preschoolers (Mage = 53.2 months, range = 36 - 72 months; 50.4% female) were assigned to either a pretend (n = 65) or control (n = 50) condition as well as to a shape or color condition. Children saw a painted wooden box, which was described as a real or pretend "blicket machine" and watched the experimenter place four blocks one-by-one on the "machine". Two of these blocks were predetermined to be "blickets" (red or cubic blocks, depending on condition). In the pretend condition, the experimenter pretended the "blickets" activated the machine by smiling and making a bell sound. In the control condition, a bell chimed from within the box. This demonstration was repeated; a memory check ensured children understood which blocks were "blickets". After a distractor task, all children were given "another" or "a real" blicket machine (same box, different color) and another set of four blocks, two of which were "blickets" using the same shape/color rule from the training phase, and told to "make the machine go". Age, condition (pretend/real), and blicket type

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(shape/color) were entered as predictors in a binomial logistic regression analysis. Whether the first block children selected in the test phase was a blicket was the dependent variable. The overall model was significant, $\chi^2(3) = 13.44$, $p = .004$, Nagelkerke $R^2 = .15$. Condition and blicket type emerged as significant predictors ($ps = .007$ and $.019$, respectively), such that children in the control condition were 3.4x more likely and children in the color condition were 2.75x more likely to select a blicket first in the test phase. Children in the control condition selected a blicket 80% of the time, significantly above chance. Children in the pretend-shape condition were no different from chance (40%), but children in the pretend-color condition were significantly above chance (71%), an effect driven by younger children (See Figure). These results suggest that pretense is an unreliable context to learn novel causal properties. Although previous research has indicated that preschoolers learn generic knowledge and causal properties (Walker et al., 2015) in unreal contexts, children did not reliably transfer a novel causal rule from pretense to reality in the present study. The fact that preschoolers do not always assume information encountered in pretense is true in reality may have important implications for early childhood education.

3-F-136 Children's reasoning about group-level social hierarchies and their desires and expectations for the future

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Young children detect power asymmetries within dyadic, zero-sum interactions, but little is known on the development of reasoning about more complex and multifaceted group-level hierarchies. We examined 5- to 10-year-old children's ($N = 144$) reasoning about a social hierarchy (presented as a business context) in which the top group was in charge, the bottom group followed orders, and the middle groups were both in charge and followed orders. We assessed participants' desired and expected positions within that hierarchy. Across participants, we varied the visual depiction of the hierarchy (Figure 1). Half of participants saw a structure with fewer people in top levels than in bottom levels (Pyramid hierarchy) and half saw a structure in which each level contained an equal number of people (Equal Numbers hierarchy). Results showed that older (vs. younger) children were more likely to perceive hierarchy as pyramid-shaped and to link prestige, wealth, wellbeing, and competence to top levels of the hierarchy. Warmth and effort, however, were linked to bottom levels of the hierarchy across ages. Children desired being at higher positions than they expected they would achieve, and the visual depiction of the hierarchy (Pyramid vs. Equal Numbers) differentially predicted girls' and boys' motivation to be at the top. Specifically, with age, boys were more likely to envision themselves at the top in the Pyramid hierarchy whereas girls were more likely to envision themselves at the top in the Equal Numbers hierarchy. Our findings suggest social hierarchy reasoning undergoes significant changes over development, and influences children's desires and expectations for the future.

3-F-137 Social positions shape how beliefs about wealth develop

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U.S. economic inequality is increasing. We questioned whether inequality influences what children and adults think the world is and should be like and investigate how these beliefs affect efforts to rectify inequality. In Study 1, we recruited preschoolers from an upper-class ($N = 53$) and a lower-class neighborhood ($N = 21$; ongoing), and a diverse group of adults ($N = 102$). We measured beliefs about the

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world across six items related to wealth and asked them to indicate on a five-point scale the kind/amount of each item that best represents what most people have and should have (e.g., kind of house most people live in). Upper-class children and adults believed that most people have ($M_s = 4.38$ and 4.20) and should have lots ($M_s = 4.30$ and 4.40), suggesting that their beliefs do not change across development. Lower-class children believed that most people have ($M = 4.38$) and should have lots ($M = 3.94$), whereas lower-class adults believed that most people have little ($M = 2.84$) but should have lots ($M = 4.21$), suggesting that throughout development, lower-class individuals' beliefs about how the world is declines, while beliefs about how the world should be improve. In Study 2, we examined how these beliefs affect generosity. We randomly assigned preschoolers ($N = 128$; ongoing) and adults ($N = 541$) to one of four conditions in which we manipulated the amount of resources they believed others and they themselves had (lots/little), and gave them the opportunity to share their resources. We found that people were consistently more generous when they believed others had less (Figure 1), suggesting that, from a young age, people's beliefs about the world impede their giving.

3-F-138 The impact of ritual on children's social group behavior

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Rituals are a pervasive feature of human culture that individuals readily engage in to facilitate group cohesion. We examined the impact of ritual participation on children's social group behavior, specifically in-group displays, and in- and out-group monitoring across 3 time points ($N = 60$ 4-11-year-olds). The results demonstrate that engaging in a ritual decreased attention to in-group peers ($\beta = -.10$, $t(49) = -3.80$, $p = .0004$). There was a significant interaction between condition and time point on time spent attending to the in-group leader ($\beta = -.10$, $t(44) = -3.21$, $p = .003$). Children in the ritual condition spent more time attending to the in-group leader than children in the control condition, but the difference between conditions decreased between time points. There was a main effect of condition ($\beta = .01$, $t(89) = 2.54$, $p = .013$) and time point ($\beta = -.01$, $t(89) = -2.06$, $p = .043$) on time spent monitoring the out-group. Engaging in a ritual increased awareness of out-group members, but overall this decreased between time points. Children showed more group-displays to the group leader in the ritual than control condition ($\beta = .01$, $t(56) = 2.71$, $p = .009$). Last, children spent less time displaying materials to in-group peers over time ($\beta = -.003$, $t(36) = -2.41$, $p = .02$). See Fig 1. These findings provide insight into how ritual participation serves to increase affiliative behaviors with group members and group leaders, which may lead to group cohesion.

3-F-139 Toddlers, but not great apes connect through social engagement during a shared experience

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Recent research showing that both toddlers and great apes behave more socially towards a partner after watching a video together raises the question whether the psychology underlying "sharing" experiences is uniquely human, or shared with other species. In the current study, we looked at the effect of active sharing (i.e. sharing through social engagement) during a shared experience on subsequent social behavior in toddlers and great apes. The (preliminary) data (60 out of 64 toddlers) suggests that toddlers, but not great apes approached an experimenter faster when that experimenter shared the experience by looking at the participant when the video started (shared experience

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condition) than when the experimenter looked at the participant at a later point in the procedure but did not actively share during the video experience (co-experience condition). This suggests that although great apes might connect through co-experiencing reality, humans sharing includes an additional social engagement aspect that might be unique to our species.

3-F-140 Naturals vs. strivers: Who do children prefer?

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Lay perspectives on success often distinguish between people who succeed because of innate talent (i.e., naturals) or hard work (i.e. strivers). How do children evaluate naturals and strivers? Do they conceive of themselves as naturals or strivers? And can parents' beliefs predict children's evaluations? To answer these questions, we presented four- to nine-year-olds ($n = 72$) and their parents with pairs of unfamiliar children who succeeded on a task due to talent ("naturals") or effort ("strivers"). We asked which child they preferred (i.e., preference) and who they saw as more similar to themselves (i.e., similarity). Interestingly, parents significantly favored strivers ($p < .001$) and saw themselves as strivers ($p < .01$; see Figure 1). Although children did not show these patterns ($ps > .05$), they were significantly more likely to choose strivers on the preference measure than on the similarity measure ($p < .01$), a tendency also observed among parents ($p = .01$). In addition, children's preference for strivers somewhat correlated with their parents' preference ($r = .23$, $p = .06$). Overall, children value strivers to a higher extent than they see themselves as strivers, and that this preference probably comes from parental influence.

3-F-141 Do 6- to 7-year-old children infer status and virtue from gossip?

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From innocuous watercooler chit-chat to conversations intended to ruin reputations, evaluative talk about others--gossip--is ubiquitous. Gossip allows important rules to be clarified and reinforced, and individuals to keep track of their social network while strengthening their bonds to the group (Fine, 1977; Foster, 2004). It may also signal important social information about the gossipier to the recipient of gossip. For example, warning group members about an uncooperative future partner or having access to information (and being willing to use it to benefit the group) may signal social status and virtue to group members. Given that gossip does not reliably occur until middle childhood (Engelmann et al., 2016), we investigated whether 6- to 7-year-old children perceive gossip as a social signal for status or virtue. Children were presented with storybooks in which two characters witness a child acting badly and also watch a TV show that they think is bad. Then, one character (Gossiper) gossips to a third character (Recipient) about the child who acted badly, and the other (Non-Gossiper) talks to the same Recipient about the TV show that was bad. A forced-choice procedure revealed that children's responses to status and virtue questions were not significantly different across conditions, $\chi^2(1, N=23) = .04$, $p = .835$, and $\chi^2(1, N=23) = 1.09$, $p = .297$, respectively. Although children have been shown to engage in some forms of gossip by the age of 5 years, more research is needed to understand whether young children indeed infer status- and virtue-related information from gossip.

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G – Cognition in diverse environments

3-G-142 Learning to concentrate: A study of sustained concentration in Montessori preschools

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Sustained attention is highly valued in educational settings, where students are required to sit through classes and timed tests. Sustained attention requires considerable executive control, a skill children are still developing. Montessori preschools teach sustained attention through individual choice. Children have freedom to choose their own activities, with the idea that having choice will help them concentrate on work for longer periods of time. Previous research has shown Montessori children do have higher executive functions, which may be aided by this practice in concentrating (Lillard et al., 2017). Observations in Montessori classrooms conducted about 100 years ago indicate that children go through a quartic curve of concentration, needing a mid-morning break (Montessori, 1918/1991). We investigate if the same pattern holds in Montessori classrooms today. We conducted 115 observations in Montessori classrooms for two to three hours each (age range = 2.9-6.2, M = 4.6), assessing concentration about every minute using a seven-item scale. Patterns of concentration varied by age. At three, a quartic model fit better than the intercept model, $p < .001$, showing mid-morning fatigue. By four, children were able to sustain attention for longer and a cubic pattern fit better than the intercept model, $p < .001$, indicating less fatigue at the end of the morning. By five, children were able to sustain attention across the entire morning, with the intercept model fitting best.

3-G-143 The development of the gender stereotypes about brilliance in Chinese young children

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U.S. children as young as age 6 associate brilliance with men, which then shapes their activity choices, leading girls to shy away from the ones portrayed as requiring smarts. However, it is unclear (1) whether children from other cultures have learned these stereotypes from early on, and if so, (2) how parents' gendered attitudes relate to their children's beliefs. Here, we recruited 96 five- to seven-year-old Chinese children and their parents in the Beijing metropolitan area. Children were presented with stereotype tasks adopted from Bian et al. (2017). For example, they were told a story about a "really, really smart" person, and were asked to guess which of four unfamiliar adults (two men and two women) was the person in the story. Parents were asked to complete measures assessing their attitudes about traditional gender roles. We found that, although 5-year-old boys and girls choose their own gender as being really smart, girls at the age of 6 start to associate high intelligence with men (see Figure 1). Parents' gender-based attitudes predict their children's endorsement of the "brilliance = men" stereotypes. Thus, the gender stereotypes about intelligence are assimilated in Chinese children around age six, which parallels the developmental pattern in the United States. These findings highlight the universality of the early-emerging gender stereotypes about brilliance, and elucidate the potential effect of parenting in transmitting these pernicious beliefs.

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3-G-144

A content analysis of the use of accents in children's animated television

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Accent refers to nonpathological variance in speech patterns and mannerisms that are associated with speakers of a particular region, class, experience level, or status in a language (Munro, 1998; Trudgill, 1995). Previous research has found that non-native accents (NNAs) and non-standard accents (NSAs) are typically underrepresented and associated with negative characteristics in primetime and children's television (e.g., Dobrow & Gidney, 1998; Dragojevic et al., 2016). Much of such work in children's media is outdated or provides confusing, ambiguous results about representations of British accents. The present study provides an updated analysis of how accents are represented in children's television in 2019 (and specifically in the Canadian context), and further improves upon past work by addressing ambivalent findings about representations of British accents. A sample of 30 children's animated television programs was selected based on frequency of airing on cable programming and/or popularity on Netflix. Fifty-four episodes were randomly selected for analysis, with all characters in each episode coded for accent, prominence (major/minor), behaviour, and appearance. Appearance and behaviour were rated using 5-point Likert scales, where 1 indicated very negative portrayal and 5 represented very positive portrayal. Accents were classified into six categories (American Non-Standard, American Standard, British Non-Standard, British Standard, International Anglophone, and Non-Native). A total of 468 characters were recorded. A chi-square test of goodness-of-fit revealed that accent types were not evenly distributed in the sample, $X^2(4, N = 467) = 885.0, p < .01$. The majority of characters spoke with an American Standard accent, representing 67.3% of the sample. Non-Native accents were the least represented accent category, with only 5.8% of characters speaking with a NNA. Accent was not found to have a significant effect on characters' behaviour ($F(4, 467) = 1.68, p = .14, \eta^2 = .018$) or appearance ($F(4, 444) = 1.55, p = .17, \eta^2 = .017$), although British Standard accents were associated with the highest behaviour ratings ($M = 3.78, SD = 1.02$), and American Non-Standard accents were associated with the lowest behaviour ratings ($M = 3.18, SD = 1.19$). Overall, NNAs and NSAs continue to be underrepresented in children's animated television, with the vast majority of characters speaking with an American Standard accent. Compared to Canadian census records of foreign-born residents (a rough approximation of how many people might speak with a NNA or NSA), children's animated television airing in Canada does not depict NNAs and NSAs with the same frequency as they likely exist in Canadian society. The positive behaviour ratings associated with British Standard accents may be partially attributable to the recent influx of British children's television programs (e.g., Peppa Pig, Octonauts) into the North American market. The present methodology, which differentiated between Standard and Non-Standard British accents, also allowed for this trend to emerge in the data. These findings suggest that, while significant evaluative differences in portrayals of different accents may no longer exist in children's animated television, there still exists the troubling problem of a lack of accent diversity.

3-G-145

Stories children tell: Exploring the relationship between story structure, receptive vocabulary and emergent literacy skills in a sample of African American Preschool children.

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For the past several decades, cognitive developmental researchers have focused their attention on investigating the literacy competence of African American preschool children. A major reason for this

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interest is the acknowledgement by scholars that children's early literacy competence predicts their school age narrative and literacy skills. The research in this area has been quite diverse. For example, Gardner, Pungello, and Iruka, (2012), explored the narrative styles of African American preschool children; whereas, Gilliam, Fargo, Petersen, and Clark (2012) looked at the use of AAVE dialect in the structure of children's narratives, and Gatlin, Wanzek, and Al Otaiba (2016) examined the link between race, socioeconomic status and preschool narrative skills. The goal of the current study is to add to this body of literature and explore the following questions: How do African American preschool children structure stories? Is there an association between their story structure, their receptive vocabulary, concepts about print and their letter identification skills? 45 African American children (49 months) were administered the PPVT, Identification of Print and Concepts about Print. Children were shown three pictures from Frog, Where Are You? (Mayer, 2003) and asked to tell a story about the three pictures. Story Structure was coded for Story Grammar Level-SGL number of story grammar elements in their stories; Narrative Length-length of stories and Narrative Diversity-diverse words used in stories. SGL was positively associated with Concepts about Print and Letter Identification. Suggestions on interventions on how to structure stories will be discussed.

3-G-146 Which aspects of cognitive flexibility are related to reading comprehension?

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Our goal was to understand the relation between various aspects of cognitive flexibility and reading comprehension during the elementary school years. One hundred one second through fifth grade children completed MAZE passages to measure reading comprehension and one of four card sorting tasks, which involved sorting object or word cards simultaneously or sequentially, to measure cognitive flexibility. Children also completed the verbal fluency portion of the D-KEFS to provide additional details about cognitive flexibility. Oral reading fluency and vocabulary were measured as control variables. As expected, all four measures of cognitive flexibility (card sorting accuracy, letter fluency, category fluency, category switching) were related to reading comprehension, as were oral reading fluency, vocabulary, and age. The correlations remained significant when controlling for age and were strongest for flexibility measures involving switching. These findings confirm that cognitive flexibility is related to reading comprehension during the elementary years and suggest that aspects related to switching may be particularly relevant.

3-G-147 Mexican-American children's explanations for how and why people get sick

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Previous research suggests children give a combination of folk (cold weather) and scientific (germs) explanations the causes of illness, though the extent to which they provide each also depends on when each type of explanation is provided in their cultural context (Sigelman, 2012). There may also be differences depending on if a child is asked why someone gets sick (e.g., why me?) versus how someone gets sick (e.g., mechanistic way) (Evans-Pritchard, 1973). Mexican-American 4- (n = 18), 5- (n = 15), and 6-year-old children (n = 19; 53.8% Female overall) were asked to list how and why people get sick in general. Children's open-ended responses were coded into 31 categories. Smith's S salience scores (Purzycki & Jamieson-Lane, 2016) were calculated for each category - grouped by why and how. These scores indicate how often each of the categories were listed in the open-ended responses within each

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group, with higher scores indicating being listed more often and higher in the list. Results showed similarities and differences in each age group, but children did not give more mechanistic responses for how (see Table 1). For how, 4-, 5-, and 6-year-olds all frequently said Irrelevant (Smith's $S = 0.322, 0.184, 0.132$, respectively) and Eating Cold Food (4-years: 0.111) or Cold Weather (5-years: 0.256; 6-years: 0.182). For why people get sick, all age groups listed Germs (0.111, 0.142, 0.112, respectively) and Cold (5-years: 0.197) or Cold Weather (4-years: 0.111; 6-years: 0.100).

3-G-148 Learning under pressure: Stereotype threat and incentivized performance pressure in the mathematics classroom

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Problem and purpose: In the current competitive educational landscape, many children feel a great deal of pressure at school (e.g. Luthar & Kumar, 2018; Watson, Johanson, & Dankiw, 2014). Coupled with this general evaluative pressure, children from marginalized groups may also worry that their academic abilities will be judged based on negative stereotypes (e.g. Larnell, Boston & Bragelman, 2014; Nasir et al., 2009, 2017). These pressures can be especially pronounced in mathematics contexts, a high stakes subject area in which stereotypes are often particularly salient (see Cimpian, & Leslie, 2017). How do these pressures shape children's learning and engagement in mathematics? While pressure can in some cases increase motivation and effort, it can also result in distracting thoughts and worries that tax executive functions (EFs) (see Maloney, Sattizahn, & Beilock, 2014). In this talk, we present finding from a series of classroom-based experiments investigating how heightened pressure during cognitively challenging mathematics instruction impacts early adolescents' immediate learning, retention and interest. We compared impacts of two different but sometimes co-occurring sources of pressure that many students experience in the mathematics classroom: stereotype threat and incentives. While both sources of pressure can increase anxiety, they differ in the extent to which identity is implicated and threatened. **Procedure and Results:** In both experiments, procedures were implemented in 3 sessions over a 2- week period using a pretest, lesson and immediate posttest, delayed posttest design. Students viewed a videotaped conceptual math lesson on individual computers in their everyday math classrooms. This methodology maximizes ecological validity while also allowing for controlled stimuli. Students were randomly assigned to condition within classroom and stereotype threat (experiment 1) or incentives (Experiment 2) were manipulated via video before learning. **Study 1:** 135 5th grade students of color (83% African American, 17% LatinX; 71 girls) were randomly assigned to a stereotype threat or Control learning condition. When race was made salient prior to instruction (Stereotype Threat Condition), students high in EFs retained less learning over time, demonstrating smaller sustained gains in accuracy and lower declines in misconception use (Figure 1). **Study 2:** 178 diverse 5th grade students (33% African American, 27%White, 26% LatinX, 13%Biracial; 88 girls) were randomly assigned to the incentivized performance pressure or control condition. Analyses detected significant interactions between student gender and experimental condition: Girls assigned to the incentivized performance pressure condition exhibited significantly smaller immediate and sustained learning gains, whereas boys in the pressure condition showed trends towards improved learning (Figure 2). **Significance and Implications:** Findings from these studies indicate that the role of pressure in shaping academic achievement extends beyond impacts on test performance to also shape initial knowledge acquisition, particularly when identity is threatened. During early adolescence, a pivotal time for academic identity construction and for developing a sense of efficacy, experiences of identity threatening pressure could

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be particularly harmful, possibly instigating recursive processes that have long-range implications for academic identities and aspirations.

3-G-149 Gender differences in adult-child interactions: Evidence from non-parent undergraduate students

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Language exposure during parent-child interactions is critical for promoting language development (Hirsh-Pasek et al., 2015). Language stimulation differs between mothers and fathers (Rowe, Leech, & Cabrera, 2017) but reasons for this difference remain unclear. The current study examined adult-child interactions with non-parent undergraduate students (N=82) during free-play with a toddler. Female participants talked more during the interaction (M = 33.42 words per minute) than male participants (M = 23.95). Language quality analyses show that male participants used more number (0.44%), space (7.25%), and Wh-question words (3.40%) compared to female participants (0.14%, 5.19%, 1.99% respectively). In contrast, female participants used more words related to mentalizing (6.33% vs. 4.84%). Our findings suggest differences in language-engagement between non-parent males and females while interacting with an unknown child. These differences cannot be explained by experienced gender roles in the household or by child-based factors as the child was held constant in our design.

3-G-150 Exploring the relation between interpretive-theory of mind and literary meaning-making: A multi-step mixed-methods study

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Formal schooling introduces children to a variety of materials to develop literacy; yet, a failure to "read on grade-level" by the fourth grade has been shown to have enduring academic and thus, personal and societal debilitating effects (Fiester, 2010). In this same period, children cognitively advance from Theory of Mind (ToM) to Interpretive-Theory of Mind (IToM) (Chandler & Lalonde, 1996). This study seeks to understand the ways in which IToM is related to reading through the meaning-making process. Literary content can be interpreted in more than one way or from more than one perspective. Could the development of IToM change children's ability to appreciate multiple interpretations of text and how might that change promote or hinder literacy and school achievement? In the first phase of this study, 50 children between the ages of 4 to 9 are being recruited and given a ToM and IToM assessment battery which requires the discerning of mental states from real-life scenarios and fictional short stories. Qualitative data is being simultaneously recorded by means of a semi-structured interview of the participants. While this study is on-going, early data shows that those who demonstrate proficiency, by way of a .5 or higher score across the ToM and IToM tasks, are better able to acknowledge and justify a variety of inferable answers regarding the protagonists' mental states and likely actions or motives in the short stories; this is, they demonstrate versatile thinking.

3-G-151 More than fun and games: play as an index of developing executive functions

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Play is universal. It engages object manipulation, social interaction, language, etc. Yet, we don't know how play indexes other developing cognitive processes. We tested 4-9-year-old Western children (N=21) on (1) Structured Play with mother and experimenter; (2) Unstructured Play; (3) several executive functions (EFs) tasks. During Structured Play, children initiated verbal interaction similarly with the experimenter and mother, $F(1,20)=1.28$, $p=.27$. Children who initiated more verbal interaction with mother relative to experimenter had poorer EFs, $r=.71$, $p<.05$. Children attended to the objects of play more than to distracters, but did so similarly during play with experimenter and mother, $F(1,13)=30.58$, $p=.000$. However, only focused play with mother correlated with better EFs, $r=.73$, $p<.05$. During Unstructured Play, children spent more time on toy play than scanning the space in search of new objects, $F(1,13)=101.12$, $p=.000$. Individual differences in toy play relative to unfocused search were correlated with better EFs, $r=.83$, $p<.05$. These data suggest that play based interactions reflect developing EFs.

Session 4

A – Perception, action, attention and cognitive control

4-A-1 A child's view is unique: Developmental differences in what is important in naturalistic scene images

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Numerous studies aimed at understanding basic cognitive mechanisms use scene images as stimuli. However, little is known about whether there are developmental differences in the kind of information that is extracted from the scenes, which could give rise to apparent effects at later stages of processing. We asked a large sample of 5-10 year old children and adults to indicate which elements of scenes they thought were important by freely coloring them in with an electronic pencil and tablet. We first calculated the average number of pixels each participant colored as a measure of how much area within the images they found to be important. Children colored significantly more pixels than did adults, suggesting they are less focal in what they find important. Next, to ask how consistent people are with one another in which elements they deem important for a given scene, we calculated the similarity in the spatial pattern drawn across individuals. We found that adults were distinct from children but highly consistent with one another. In contrast, children showed low consistency with each other, indicating high variability in what individual children found to be important. Taken together, our data show that children engage with scene images in a broad and individually unique way. Future work should consider how both developmental and individual differences influence the kind of information that children extract from scenes--and perhaps their environments more generally.

4-A-2 Fantasy orientation and self-regulation: Does self-regulation differ for fantasy oriented preschoolers in a classroom context?

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Research using direct assessment and parent report suggests that children with high fantasy orientation (FO; fantastical imaginations and pretense) have better self-regulation, executive function (EF) and emotion knowledge (Gilpin et al., 2015; Pierucci, et al., 2013; Thibodeau et al., 2016; White & Carlson, 2016). However, teacher reports suggest the opposite (Gilpin, et al., 2019). Little is known about the

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regulatory behaviors of these children in a natural, peer setting, such as a classroom, which may explain the teacher reports. Preschoolers, ages 3-5 (N= 60) completed direct assessments of FO, EF, ToM, emotion understanding, and vocabulary. Children's parents and teachers provided informant reports on the same constructs in the home and classroom contexts respectively. Additionally, preschoolers' play, peer interactions, activity level, emotionality and self-regulation was observed in classrooms using time sampling in 3 different contexts: instruction time, structured play, and free play. Data from classroom observations suggest that observed pretend play is strongly positively correlated with observed positive emotions ($r = .54$, $p = .01$) and observed activity level in the classroom ($r = .89$, $p < .001$). Final results including data from the parent and teacher reports may provide insight into whether or not children with high fantasy orientation differ from their peers in terms of self-control and emotion regulation in the classroom.

4-A-3 Exploration and exploitation in development: Charting shifts in decision-making strategies across childhood

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Exploration is a critical activity in which one seeks information that can be used later to make rewarding decisions. But, making effective choices requires balancing exploration with exploitation (maximizing reward using existing information). Previous studies have shown that children explore in response to surprising events or confounded evidence, but little is known about how they balance exploration and exploitation or how these processes change with development. To examine these questions, a large sample (N = 190) of children between 3 and 8 years old and adults performed a simple choice task in which, on each of 100 trials, they chose one of four options that gave different amounts of reward. Modeling analyses of choice patterns reveal the relative contributions of several factors: random responding, reward-based responding, and systematic switching. Adults and most 7-8-year-olds were overwhelmingly reward-based, while there was little influence of reward on 3-4-year-olds' choices. Despite largely ignoring reward magnitude, younger children were not random--instead they were strongly characterized by systematic switching. The results also indicate discrete shifts in strategy (from pure switching to reward-based), rather than a continuous change over time. These findings suggest that, rather than a simple increase in decision-making ability with development, choices may be guided by different goals at different points in life. While adults' choices may be optimized to extract rewards from the environment, young children's choices are tuned to facilitate broad information gathering to build a foundation of knowledge for use later in life.

4-A-4 Attentional capture in goal-directed action during childhood, adolescence, and early adulthood

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Action-centered models of attention propose that attentional capture by a distractor (e.g., a salient but task-irrelevant object) can automatically generate response activations corresponding to the distractor's location. In other words, these models propose that attentional capture can result in the automatic capture of action. Action-centered models of attention have received support from research measuring the spatial and temporal characteristics of adults' hand movements. However, such hand-tracking techniques have not been used to investigate the dynamics of attentional capture in children and

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adolescents. To address this gap in our current understanding, we presented 5-year-olds, 9-year-olds, 13- to 14-year-olds, and adults ($N = 96$, with 24 participants in each age group) with a visual search task in which participants responded by reaching to touch targets on a digital display. Consistent with action-centered models of attention, the effects of attentional capture by distractors were observed in participants' movement trajectories by as early as 5 years of age. Further, significant age-related reductions in the costs of attentional capture were observed in movement times between childhood and adolescence. In addition to presenting novel insights into the development of attention and action, these results highlight the benefits of incorporating hand-tracking techniques into developmental research.

4-A-5 Visual saliency guides orienting to dynamic faces in infants, children, and adults

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The current study tested for developmental changes in how bottom-up visual information guides attention to faces when viewing dynamic media. In prior work with static images, participants more frequently looked to visually-salient faces (based on a computational saliency model that combined intensity, color, and orientation information) compared with non-salient faces (Amso et al., 2014). However, saliency only facilitated face looking in participants 12 months and older. We extended this work by testing faces in videos because: 1) dynamic visual features (i.e., motion and flicker) might help infants orient to faces, and 2) infants and children are more likely to encounter dynamic (as opposed to static) faces in digital media and daily life. 99 participants (6mo-10yr and adults) viewed five 2 min television clips while their eye movements were recorded. Areas of interest were drawn around each face on each video frame. A computational saliency model with static and dynamic features determined whether each face on each video frame was salient (contained the most salient pixel) or not (contained no pixel \geq 80th percentile). Across ages, participants fixated salient faces 20.5% of the time but non-salient faces only 8.5% of the time (Figure 1). Unlike past work, this difference was evident in infants as well as children and adults. These results reveal that observers 6 months and older reliably orient to faces in complex video sequences based on bottom-up features.

4-A-6 Investigating the developmental trajectory of learning by doing: Is doing beneficial when attention is still developing?

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Research with adults suggests learning by doing yields better learning outcomes than passive instructional activities (e.g., reading). However, interactive practice might rely heavily on selective attention to relevant information and feedback, which may make it challenging for young children. Conversely, it is possible doing requires less attentional control than listening/reading and is therefore less challenging for young children. We investigated the developmental trajectory of learning by doing. Sixty-seven primary students ($\text{Mage}=6.68$ years) listened to a lesson about insects. During the lesson, participants learned about the features of insects and were presented with animal pairs (e.g., ant | pillbug). First-graders who were told which animal was the insect and given the diagnostic criteria before being asked to identify the insect (Passive Condition), performed better on the subsequent post-test than those who made predictions prior to receiving any instruction (Doing Condition); Post-test Ms:

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Passive=.87, Doer=.64, $p=.005$. There was no significant condition difference for kindergartners ($p=.65$). Results suggest learning by doing might depend heavily on the development of selective attention.

4-A-7 Developmental differences in attention to action-specific information

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Visual attention when observing action sequences depends on developmental differences in understanding actors' goals. However, more general aspects of attention (not specific to action)--such as narrative comprehension--also change with age (Kirkorian, Anderson, & Keen, 2012). General attention development is indicated by increasing similarity in where other observers look when watching the same video--stronger inter-subject correlations (ISCs). How, then, can we disentangle action-specific from general changes in attention? We measured how well children's (3.75-4.25 years) and adults' gaze was predicted by the 'locus of action' (LOA)--the screen coordinates at which hands and objects interact at each moment. The LOA provides a prediction of attention that is sensitive to the dynamic nature of action-specific information. We compared the action-specific LOA to a general measure (ISC) while participants watched a video of a complex action sequence. A significant interaction revealed that even though ISCs were similar between age groups, adults' looking to the LOA was stronger compared to children's LOA looking (Figure 1). This suggests that action understanding influenced attention above and beyond more general developmental differences. Children may not yet be using action-specific locations in the same way or to the same degree as adults. Planned analyses will whether this is due to a lag in visual attention as children attempt to "keep up" with the complex action sequence.

4-A-8 Learning the obvious: How mothers teach the designed actions of everyday objects

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Many everyday artifacts require specific designed actions to use the object as the designer intended (e.g., twisting open a jar). Recent work found a developmental progression in children's learning of designed actions--from exploration (12 months), to display of the designed action (18-24 months), to successful implementation (30-36 months). Lags between exploration, display, and implementation reflect the unique cognitive, perceptual, and motor requirements of each artifact. Often, caregivers provide social information to help children learn the requirements, but not all input is equally informative (e.g., encourage, highlight the designed action, aid in implementation). To determine how social input changes with children's age and skill level, we asked mothers to teach their 12- to 36-month-olds ($N=76$) to open containers with twist-off and pull-off lids. Across children's age, mothers decreased their manual and verbal inputs ($r(74) > .33$, $ps < .003$) and changed the type of input. For 12-month-olds, mothers highlighted the designed action via demonstration (63% of behaviors); for 18- to 24-month-olds, mothers helped implement difficult actions (e.g., stabilizing the container, 35% of behaviors) and supplemented with verbal directives; and for 30- to 36-month-olds, although overall rates of input were low, mothers predominantly gave encouragement (19% of behaviors). We are currently examining how children's behaviors affect the real-time ebb and flow of mother input.

4-A-9 Examining the relations between performance-based and parent-report measures of executive function in preschoolers: A multilevel modelling approach

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Executive function (EF) is a construct that comprises higher-order cognitive control processes including three fundamental components: inhibition, working memory, and cognitive flexibility. There are two major types of EF assessments: performance-based (PB) and rating measures. Using a multilevel modelling approach, the current study examined the longitudinal relationship between PB and parent-rating (BRIEF-P) measures in preschoolers. To date, a total of 88 typically developing preschoolers (36-48 months old) were recruited. Children were assessed three times in half-year intervals on both PB and BRIEF-P. Based on previous literature, children's family income and temperament (effortful control) were included as covariates. Results indicated significant correlated baselines and changes between PB and BRIEF-P in inhibition and working memory, but not in cognitive flexibility. In addition, there were significant negative correlations between intercepts and their corresponding slopes for both PB and BRIEF-P. The relative contributions of covariates on intercepts and slopes of PB and BRIEF-P varied and will be further discussed during the presentation. These results suggest both similarities and differences in patterns of association between PB and BRIEF-P over time. This study adds to the literature, providing important research and clinical implications with regard to the different ways of operationalizing and measuring EF.

4-A-10 Early dimensional label learning predicts dimensional attention

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Previous research suggests that learning labels for visual features may be an important building block for the recruitment of dimensional attention, also known as the dimensional label learning (DLL) hypothesis. A previous dynamic neural field model has developed this hypothesis to explain development in performance on the dimensional change card sort task (DCCS). The DCCS requires children to first sort cards by either shape or color and then to switch and sort by the other dimension. Typically, 3-year-olds will fail to switch rules, but 4-year-olds will have little difficulty switching. The model of this task is composed of two systems, one that binds visual dimensions such as shape and color to spatial locations, and another that forms associations between labels and visual features. By activating labels such as "color", the model can enhance the activation for the associated features and engage in rule-like sorting behavior. A key aspect of this model is that performance during the post-switch phase depends upon the strength of associations between labels and visual features. With weak associations, the model perseverates and continues using the initial set of rules, but with strong associations the model can switch and sort by the post-switch dimension (Buss & Spencer, 2014; 2018). A key prediction of this model is that learning labels for shape and color dimensions is a key mechanism underlying the development of flexible rule use. The goal of this study was to explore the DLL hypothesis longitudinally from 33- to 45-months of age. First, we investigated patterns of activation while 33-month-old children performed a battery of dimensional label (DL) tasks including production, comprehension, matching (see Figure 1a; Sandhofer & Smith, 1999; Verdine, Lucca, Golinkoff, Hirsh-Pasek, & Newcombe, 2016). We used functional near-infrared spectroscopy (fNIRS) to measure hemodynamic activity from left frontal, left temporal-parietal, and right parietal regions previously implicated in dimensional attention (Buss & Spencer, 2018). Activation patterns were registered to anatomical locations as described by Wijekumar, Huppert, Magnotta, Buss, and Spencer (2017). Patterns of activation differed based on

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both task type and dimension of stimuli, but groupwise activation was found in left middle frontal gyrus (MFG), bilateral supramarginal gyrus (SMG), and right angular gyrus. One year later, we administered the DCCS and examined how early DL activation was associated with performance. We found bilateral associations between DCCS performance and activation during shape and color comprehension, in addition to lateralized associations between DCCS performance and activation during the matching tasks for shape stimuli specifically (see Figure 1b). Lastly, children were also given a Flanker task that was not expected to be related to activation during the DL tasks given that it should not recruit dimensional attention. We found that performance on the Flanker was unrelated to activation during the DL tasks. These results therefore provide support for the DLL hypothesis, as performance in the DCCS task was meaningfully and selectively related to earlier activation in the DL tasks. This suggests that learning labels for visual features is a causal mechanism that gives rise to dimensional attention development.

4-A-11 Does motor ability and recency of motor behaviour influence perception of possible and impossible crawling and walking PLDs in toddlers and adults?

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The early development of biological motion perception has been given considerable attention (Blake & Shiffrar, 2007). However, little work has used eye tracking to directly compare toddlers' perception of biological motion to that of adults. We examined three-year-olds' (n=29) and adults' (n=35) looking durations to human PLDs within several AOIs (i.e., full figure, upper body, and lower locomotion-dependent area) to investigate the relationship between motor experience and motor perception. Visual processing differences were indicated across age groups for body possible, body impossible, and scrambled versions of human crawling and walking PLD stimuli. For example, toddlers looked at the full figure longer during the impossible compared to the possible walking PLD ($p < 0.01$), yet adults watched the impossible walking more than the possible and scrambled walking only within the lower locomotion-dependent area ($p = 0.006$; $p < 0.01$). Neither age groups' looking durations to AOIs differed across crawling PLD versions. Results suggest extent of motor ability and recency of motor behaviour influence motion perception.

4-A-12 Domain-general perceptual certainty in early childhood

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From an early age, children can reason about the certainty of their perceptual experiences, such as differentiating between being sure vs. unsure of how many cookies are on a plate. Two competing theories have emerged about the representational nature of perceptual certainty. Under one, certainty is represented as a mathematical transformation of the perceptual signal itself (e.g., the standard deviation of a neuronal tuning function; Maniscalco & Lau, 2014), and is therefore highly domain-specific: where perceptual representations are independent of each other, the certainty signals should be, as well. Under the other theory, certainty is represented in a more domain-general format (e.g., the probability of an outcome being true), allowing otherwise independent perceptual dimensions to be compared in their certainty (De Gardelle & Mamassian, 2014). While work with adults has frequently found evidence for domain-general perceptual certainty, showing, for example, that certainty in spatial frequency discrimination is correlated with certainty in orientation judgements (De Gardelle & Mamassian, 2014), the developmental picture is limited and so far inconsistent with this work. In one

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study, 5-8-year-old showed dissociations in their ability to evaluate certainty across distinct perceptual domains (e.g., number and emotion perception; Vo et al., 2014, see also Geurten et al., 2018). Here, in two experiments, we provide evidence that perceptual certainty is domain-general in children as young as six. In the first experiment, 6 - 9 year-old children perform either three perceptual discrimination tasks (Number: which side has more dots; Area: which blob is bigger; and Emotion: which face is happier), or a relative certainty judgement, in which children see two discrimination trials varying in difficulty (e.g., an easy and a hard number trial), and had to judge which of the two trials they are more certain of answering correctly. We find that while children's perceptual discrimination accuracy is unrelated across the three dimensions, that children show strong correlations across the three certainty tasks, providing evidence for shared perceptual certainty representations. In the second experiment, we conduct a more stringent test of domain-general by asking children to make within- vs. between-domain comparisons of their certainty. If certainty is truly domain-general, children should be able to compare their certainty states across perceptually distinct dimensions just as effectively as they can compare it within these dimensions. Forty-eight 6 and 7-year-olds were presented with Number, Area, and Emotion perceptual discriminations. Questions were presented in pairs - either Within-Dimension (e.g., number/number) or Between-Dimensions (e.g., area/emotion). After making the discrimination decision for each of the two trials, children reported their relative certainty in the questions ('which answer are you more sure you got right?'). Consistent with a domain-general account, children were able to compare their certainty between different perceptual task types, $t(47) = 3.73$, $p < .001$, $d = .54$, which was not different from their performance on comparisons within the same perceptual task type, $F(1, 47) = .075$, $p = .39$. Together, these results suggest that - by age six - children's perceptual certainty is represented in a domain-general format.

4-A-13 Thoughtful cardio? Investigating the immediate impact of cognitively engaging physical activity on preschool children's executive function

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Executive function (EF) skills are cognitive skills that help organize and control goal-directed behavior (Zelazo, Blair & Willoughby, 2016) and influence attentional, emotional, and physiological responses to stimulation (Blair & Raver, 2014). These skills are important for a wide-range of outcomes including school learning (Diamond & Lee, 2011). Current research with adolescents and adults provides support for a connection between physical activity and EF (Best, 2010), but only a few studies have investigated this relationship in preschool children. Early EF development provides children with a noticeable advantage at school entry (Blair & Razza, 2007), an advantage that continues to accrue, with higher achievement (Raver et al., 2011). But what type of physical activity promotes EF? Here, ninety 4- and 5-year-old children participated in a pre-test, intervention, post-test study to differentiate which physical activities lead to the greatest immediate improvements in preschool children's EF skills. Preliminary results indicate a significant effect of intervention activity on working memory $F(3, 86) = 3.24$, $p = .026$. Additional analyses for inhibition, shifting, and overall executive function will be completed prior to this presentation. These results have important implications for children's school readiness.

4-A-14 Pretend play differentially impacts cognitive development among middle-class and low-income children: An experimental study

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Growing evidence supports pretense as a positive predictor of executive function (EF) in early childhood. Thibodeau et al. (2016) found that a pretend play intervention led to EF improvements, especially among children who naturally engaged in a fantastical style of pretense. However, these authors called for experimental investigations of pretense in at-risk populations, controlling for style of pretense. As such, the present study included 188 preschoolers (40% at-risk, in Head Start). Participants were randomly assigned to one of four conditions: fantastical pretense (e.g., pretend trip to moon), representational pretense (e.g., pretend restaurant), non-imaginative play (e.g., hopscotch), or business-as-usual control, with no pretest group differences. After 5 weeks of daily intervention, children in the fantastical pretense condition demonstrated significant improvements in EF, whereas other conditions did not, but only among the middle-class sample ($F=5.3$, $p=.04$). Consistent with previous findings, these data suggest that fantastical pretense can facilitate EF development among middle-class children. Low-income children did not benefit from this intervention, perhaps due to lower levels of engagement ($F=22.2$, $p=.00$) and lower initial propensities towards pretense ($F=7.3$, $p=.01$). These data highlight the need to further investigate the role of pretense in at-risk populations to better understand if and how pretense might facilitate development for these children.

4-A-15 Relations between divergent thinking and executive function in early childhood

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Despite evidence that executive function (EF) contributes to adults' divergent thinking (DT, a key element of creativity), developmental research on this link remains sparse. In a prior study using the Alternate Uses Task (AUT) to assess DT, we found that preschoolers generated more original uses for novel objects than more familiar ones - possibly due to a need to inhibit prior associations. The current study aimed to further probe the role of EF by replicating this effect within-subjects, and testing whether EF predicts its magnitude or mean-level DT scores. Typically developing 5-year-olds ($N=72$) completed three EF tasks, six trials of the AUT (two each with very familiar, somewhat familiar, and novel objects), and an IQ test. Initial analyses of AUT fluency (number of ideas) showed no main effect of object novelty, and no interaction between novelty and EF. There was, however, a negative association between EF and mean-level fluency, which persisted when controlling for age and IQ ($\beta = -.40$, $p<.01$). Though apparently inconsistent with our prior findings, these results support proposals that exerting EF can interfere with free idea-generation (fluency). EF has also, however, been proposed to support idea-evaluation and idea-search strategies, which might be more directly reflected in the flexibility and perhaps originality dimensions of DT. Future analyses will test this in our data by examining the effect of EF and object novelty on AUT flexibility and originality.

4-A-16 Preschool children use weight and sound in causal reasoning tasks

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Four-year-olds can categorize identical-appearing objects by weight (Wang, Meltzoff, & Williamson, 2015) and use weight as a causal variable to produce desire outcome (Wang, Williamson & Meltzoff, 2018). In this study, we examined whether and when preschool children can use weight or/and sound as causes to infer the location of the target objects. Three-, four-, and five-year-olds ($N = 60$) were presented with two identical-appearing boxes, which can be differentiated either by weight or sound or both. The results showed that 4- and 5-year-olds chose the correct location significantly more than 3-year-olds, $F(2, 57) = 4.40$, $p = .017$. Children inferred the correct location on significantly more trials when weight or sound was used to distinguish the boxes than when both weight and sound was used, $F(2, 114) = 4.37$, $p = .015$. Discussion will focus on the combine role of age and pedagogical cues in promoting cognitive development.

4-A-17 Automated study challenges the existence of innate sensitivity for self-propelled causal agency in newborn chicks

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What mechanisms underlie social cognition in newborn brains? A seminal study reported that newborn chicks prefer to associate with self-propelled objects over objects that moved as a result of physical contact, suggesting that the distinction between animate and inanimate objects is part of a newborn's innate representational repertoire (Mascalzoni, Regolin, & Vallortigara, 2010, PNAS). While this study tackled an important theoretical question, the study had three limitations: noisy measurements (low signal-to-noise ratio), small effect sizes, and high analytic flexibility. Using a preregistered design, we attempted to reproduce this finding with an automated method that eliminated experimenter bias and allowed over 400 times more test data to be collected per chick. With precise measurements of each chick's behavior, we could perform individual-level analyses and substantially reduce measurement error for the group-level analyses. We found no evidence that newborn chicks prefer objects that exhibit self-propelled motion (mean = 51%, SE = 5%, $t(11) = 0.29$, $p = .78$, Cohen's $d = 0.08$). However, the chicks demonstrated a strong preference for familiar objects over novel objects (mean = 74%, SE = 2%, $t(11) = 9.94$, $p = 0.0000008$, Cohen's $d = 2.87$), showing that our automated method can produce robust results. These results challenge the claim that sensitivity to self-propelled object motion is an innate cue for agency detection in newborn brains.

4-A-18 Children's experience and exploration of touch-screens

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This research explores how children interact with and understand the properties of touch-screens through both survey and experimental methods. We collected online survey data from parents about their children's screen use in order to determine how much time kids of different ages are spending with various types of screens and what that screen time looks like (e.g. educational vs. entertainment). We also recruited young children (7-10 months and 15-18 months) to study the manual behaviors (rubs, pats, scratches, grasps, and screen behaviors) they direct towards screen images as compared to the behaviors they direct towards photographs and 3D objects. Survey data collection is ongoing, but preliminary results suggest that screen time increases with age. Results from the experimental data suggest that 15-18-month-old children grasp and scratch significantly more towards objects than photographs (grasping objects vs. grasping photos $t(9) = -3.34$, $p < .01$; scratching objects vs. scratching

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photos $t(9) = -.245$, $p < .05$). Compared to the 7-10-month-old children, 15-18-month-old children also grasp more to screens ($F(1,28) = 5.02$, $p < .05$). Our data suggests that although screen images are arguably more similar perceptually to 2D photographs, children are picking up on the interactive nature of screens and showing signs of recognizing that these images may afford manual manipulation as early as 15-18 months. Experimental results of touch-screen exploration will be discussed in light of survey findings on screen use by children and their parents.

B – Memory and reasoning

4-B-19 Future thinking and memory: Addressing a key criticism of the spoon task

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The item-choice, or "spoon," task (Tulving, 2005) has become the primary means of studying future thinking in children. In this task, children encounter a problem (e.g., locked box) and are later given the opportunity to select an item (e.g., key) to address it. However, this task may not require foresight, per se, as children could succeed by associating the correct item and the past problem. Indeed, previous research (e.g., Atance & Sommerville, 2014; Scarf et al., 2013) shows that task failure is primarily due to limitations in memory, rather than limitations in foresight. The present study reduces the possibility that children pass the item-choice task using association by making the items from which they must select of equal associative value. We further investigate the role of memory with a retest component in which children re-select an item after receiving corrective memory feedback. Of 22 4- to 7-year-olds (projected $n = 60$), all age groups performed at chance level on the item choice. During the retest phase, administered only to children who selected incorrectly ($n = 13$), 6-year olds had a higher tendency to change their item selection (72%), compared to 4- and 5-year-olds (0%). 7-year olds did not require the retest. This finding seems to indicate an age-related increase in the role of memory when controlling for association. More broadly, this design will provide necessary insight to the specific roles of associative strategies and memory on the item-choice task.

4-B-20 Can toddlers learn causal action sequences?

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Toddlers, like older children and adults, can learn cause-effect relationships between a single action and its outcome through observation. However, causal relationships in the real world are often more complex than this. The present study investigates whether one- and two-year old toddlers can learn that a sequence of two actions is necessary to bring about an effect. In Experiment 1 ($N=67$) toddlers watched an adult manipulate an action (A) on a puzzle-box, followed by a second action (B), following which a sticker was dispensed (effect E). They also watched the adult manipulate just action B, which did not produce a sticker, demonstrating that the sequence A-B was necessary to get a sticker. Toddlers were then given the opportunity to interact with the box. If they manipulated A followed by B a sticker was dispensed, up to a maximum of five times. Preliminary analyses show that, on their first attempt, toddlers were equally likely to manipulate either A or B first ($33/67$, $p = 1$, exact binomial test), though only 29% of toddlers immediately manipulated A followed by B (i.e., performed the required causal action sequence). There was also no effect of age group, Fisher's exact test, $p = 0.62$). Given that toddlers seem to have some difficulty learning causal action sequences, Experiment 2 (ongoing) aims to

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investigate how 3- to 5-year-olds perform in this task, while Experiment 3 (ongoing) investigates whether toddlers can learn that a sequence of actions is not necessary. Our findings will improve our understanding of the developmental emergence of learning about causal relationships from observing the outcomes of others' actions.

4-B-21 Relations between autobiographical memory and hippocampal subregion volumes in early childhood

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Adults only remember a mere fraction of childhood experiences. This phenomenon, referred to as childhood amnesia, may be due to changes of the underlying neural network supporting memory (Willoughby et al., 2012; Bauer, 2007). The hippocampus is one structure within this network shown to be critical for memory in school-aged children and adults (Ghetti & Bunge, 2012) and undergoes significant development during early childhood (Lavenex & Lavenex, 2013). Thus, the hippocampus is a likely candidate underlying behavioral changes (Riggins et al., 2016). In the present study, children aged 4 to 8 years participated in autobiographical memory interviews and MRI scans. Autobiographical memories were scored using a modified autobiographical interview coding scheme based on Levine et al. (2002). Hippocampal volumes were derived via Freesurfer (Iglesias et al., 2015) and Automated Segmentation Adapter Tool (ASAT, Wang et al., 2011). Preliminary results indicate that, after controlling for age and sex, hippocampal body volume (but not head/tail volumes) correlates with total episodic recall scores, which signify remembered details requiring mental time travel. These findings represent some initial data supporting the hypothesized link between the offset of childhood amnesia and brain development. Future analyses will examine how episodic recall relates to cortical thickness measures and laboratory-based memory tasks.

4-B-22 Four- to 7-year-olds can design unconfounded experiments to learn causal relations about simple causal structures

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Findings that suggest children can engage in precocious causal reasoning involve children making inferences based on data presented to them by an experimenter, not data they construct themselves. Such findings are typically at odds with research suggesting children lack the ability to design unconfounded experiments that isolate variables (i.e., use the "Control of Variables" strategy). To bridge this gap, we suggest that the number of variables that could affect an outcome provides information processing demands that affect children's causal inference. Reducing the possible variables children must consider reduces these information processing demands. In particular, these latter studies ask children to learn a causal structure by isolating 4-5 variables individually. We presented 4-7-year-olds with ambiguous causal information about only a pair of potential causes, and then gave them the opportunity to design interventions to learn the causal structure. The majority of children (62% of the sample) designed the appropriate intervention. Children who did so were more likely to come to the appropriate causal conclusion (65% vs. 50% of the time). These data suggest that children have nascent capacities to engage in the control of variables strategy during the early school-age years and can design interventions to learn causal structures for a small number of variables.

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4-B-23 Can search inefficiency improve learning?

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What do we prioritize when learning something new, for example, how to activate a novel toy? Finding the answer as quickly as possible, or maximizing long-term memory retention? Previous literature shows that question-asking efficiency increases across the lifespan, with younger children favoring a relatively inefficient, Hypothesis-scanning (HS) strategy, which targets only one hypothesis at a time. From around age 7, children begin to rely more on a more efficient, Constraint-seeking (CS) strategy, which targets several hypotheses at a time, until this becomes the default strategy in adulthood. Younger children's inefficiency is usually considered a disadvantage, but it might confer other benefits: less efficient strategies may result in better memory for some of the stimuli considered, the relationships learned, or the learning process. For instance, asking about - and therefore paying attention to - each candidate hypothesis one by one may improve memory for all the objects considered, instead of just the correct solution. In the present study, we explore for the first time the impact of different question-asking strategies on task-related memory across childhood. Five-, 7- and 10-year-olds played 4 rounds of the 20-Questions game, where they had to identify, amongst a set of objects, the one that activated a machine by asking as few yes/no questions as possible. To disentangle the effects of following a particular strategy from the effects of actively implementing it, each participant played in two conditions. In the Active condition participants could ask their own questions, whereas in the Yoked condition they watched the game being played following one of three simulated strategies: two HS strategies, where the answer was found in 3 or 8 questions, and a CS strategy where the answer was found in 3 questions. We then assessed children's memory for the target object, the other objects presented, the machine that object activated, and the questions they had asked, at two time points: after 20 minutes, and after 1 week. Data collection is currently ongoing and is expected to be completed in August 2019. Preliminary results with 5-year-olds show that they only asked HS questions in the Active condition, in line with previous results. We therefore cannot compare the impact of different active question-asking strategies on memory with this age group. The Active condition facilitated recall of the target object, but recall of the machine associated with each set, and of the questions asked during each game were similar between conditions. Overall, learners were better able to remember non-target objects seen during the task in the Yoked condition, suggesting that attention may have been allocated more equally to all objects in this condition. We found no difference in performance between children yoked to HS or to CS strategies, possibly because 5-year-olds are not yet able to process the differences between the different strategies they are yoked to. Analyzing older children's results, where we expect more variability in active question-asking strategies, will allow a more direct test of our hypotheses.

4-B-24 The trajectory of counterfactual simulation in development

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Counterfactual reasoning is a key feature of adult reasoning. However, children show striking difficulties with counterfactual reasoning. The age at which children consistently provide a correct answer to the question "what would have happened?" varies across the literature from as young as 4 years old to as old as 12, depending on the nature of the task (e.g., blicket detectors vs. narratives). However, "failure" can take different forms. Sometimes children respond randomly, and sometimes they overwhelmingly give the incorrect answer. The underlying reasoning processes behind these patterns remain unclear. Here, we aim to provide a more systematic account of not just when children succeed at answering counterfactual questions, but also how exactly they fail.

Children ages 4, 5, and 6 ($n=24/\text{group}$) watched 6 short animations of a soccer ball entering a field on a horizontal trajectory, and then deflecting diagonally off of a block. Children were asked to make counterfactual judgments about what would have happened if the block had not been on the field by choosing one of four images showing different counterfactual possibilities. These four images varied systematically along two features of the event: Whether they preserved the ball's point of origin from the original event (vs. a different location), and whether they preserved the ball's initial (horizontal) trajectory from the original event (vs. a diagonal trajectory). See associated figure for an example item, full stimuli and data are available at <https://osf.io/5jw6y/>

We found that 6-year-olds consistently choose the correct option ($M=60\%$), while 4- ($M=31\%$) and 5-year-olds ($M=34\%$) did not. However, across all age groups, children were highly likely to select one of the two options that preserved the point of origin (all ages $>70\%$). Younger children would often select the option that preserves the origin but shows the ball moving in a diagonal trajectory. We applied a multinomial processing tree (MPT) model to children's responses which, in short, suggested that all children who engaged in simulation were very likely to preserve the point of origin of the ball, but the likelihood of preserving the ball's initial trajectory increased significantly between 4-5-year-olds and 6-year-olds. We are now piloting an experiment to rule out an alternative strategy that some younger children may use in this task: Selecting an option showing a path most similar to the one they saw in the original event. In this experiment, children see two events, one in which the ball deflects off the block and one in which it does not make contact with the block at all. Then children choose one of two counterfactual images: One in which the block is absent, but the path the ball takes nonetheless deflects as though the collision had occurred (a path identical to the collision event), and one in which the block is absent and the ball simply proceeds straight across the field (identical to the no-collision event).

We argue that when children "fail" at counterfactual tasks, they often engage in highly systematic reasoning, using the same underlying cognitive process that they will one day use to succeed, but with different assumptions or parameters. In future work, we will explore why origin is maintained more than trajectory, and what cognitive changes occur between 4 and 6 that allow children to engage in more adult-like counterfactual simulations.

4-B-25 Expecting the unexpected: Children's over-exploration facilitates adaptation to a changing world

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When making decisions, children exhibit a tendency to persist in the systematic exploration of suboptimal options, despite awareness of what the best options are. What purpose could this over-exploration serve? Using a task where adults ($N = 72$) and children (6-12 years, $N = 72$) learned to choose the most rewarding option from four alternatives, we test the hypothesis that children's over-

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exploration reflects an information-seeking bias that is advantageous when dealing with a changing environment. In a baseline condition, the reward structure remained constant during testing. In an experimental condition, there was an unsignalled change in reward structure after half the trials, with a previously low-reward option becoming the highest-reward option. In Studies 1 and 2, we replicate prior findings that children explore more than adults, as operationalized by the rate of response switching and exploratory choice. Notably, we also find evidence that over-exploration facilitates children's ability to detect changes in the environment; children were more likely than adults to discover change, and to correctly identify rewards associated with the novel options. In Study 3, the task was modified to examine whether children persist in over-exploration when full feedback is given about both chosen and forgone rewards. We discuss the implications of our findings for understanding exploratory behavior in childhood, as well as implications for emerging conceptualizations of curiosity.

4-B-26 Centrality, cue validity, and the development of conceptual reasoning

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Prior research has found that feature centrality is an important aspect of conceptual knowledge and may underlie many facets of category-based reasoning. Additionally, there is considerable debate regarding when and how conceptual knowledge enters into young children's reasoning. The current study aims to use centrality in order to better understand the onset and development of the use of conceptual knowledge when reasoning about categories. We taught 4-5 year old children as well as adults (final N = 94) two categories whose features had a causal dependency structure, and therefore differed in centrality. Then, participants were instructed to generate ideal exemplars of the two categories. Interestingly, neither group's feature selections showed a significant preference for central over peripheral features. Instead, we found an increase in the use of cue validity to generate ideal exemplars from childhood to adulthood. We discuss the implications of this finding regarding the development of induction as well as theories of conceptual representation.

4-B-27 Events structure memory less in children than adults

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In everyday experience, adult memory is shaped by parsing experience into manageable events, referred to as event segmentation (Zacks, Tversky & Iyer, 2001). Specifically, content within an event has been shown to have a privileged state of accessibility for adults, which is quickly lost after entering the next event. However, little is known about whether event structure impacts memory in children, especially given their reduced experience with events. The present study explored the possible differential impact of event segmentation on children and adult's memory. 57 children (aged 7-9 years) and 60 adults (aged 17-38 years) were presented with two cartoons which were interrupted at points occurring either within an event or across an event boundary. During these interruptions, participants were asked to select objects that recently occurred in a forced-choice task. We found that adults and children were both more accurate ($\beta_{\text{adult}} = 0.91, p < 0.001$; $\beta_{\text{child}} = 1.15, p < 0.001$) and faster ($\beta_{\text{adult}} = -0.19, p < 0.001$; $\beta_{\text{child}} = -0.10, p < 0.001$) to correctly remember objects that occurred within compared to across an event boundary. Such results suggest that both children and adults segment events in a structured manner. We additionally observed an interaction between age and event type in reaction times ($\beta_{\text{event} \times \text{age}} = 0.07, p < 0.05$), such that children's responses differed less for objects that occurred

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within vs. after event boundaries than that of adults. These results suggest that, while the spontaneous segmentation of complex events emerges by middle childhood, children's representations of these events are less structured than adults'.

4-B-28 Get with the times: Young adults' dating of components of popular culture from their adolescence

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We examined participants' dating of components of popular culture and explored possible influences on performance. Stimuli represented distinctive components of years corresponding to younger college students' adolescence, determined by the use of "Google Trends" to have extensive initial but limited continuing attention. Items represented different categories. Participants (N = 84) reported the dates the items had occurred and rated aspects of the stimuli. Dating accuracy was operationalized as the ratio of the error in months divided by the months since the stimulus occurred. A main effect of item type was observed; "social" items (movies, cultural fads/memes) were recalled better than news items, although all stimuli were rated as familiar. Post-hoc analyses indicated that participants dated social items from their middle-school years more accurately than those from their high school years. It may be that popular culture was particularly salient during early adolescence when peer influences are especially important.

4-B-29 The exploration advantage: Children's instinct to explore allows them to detect information that adults miss only when the environment is changing

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Many parents have the frustrating experience of buying an expensive toy, only for their child to be more interested in the box it came in rather than the toy itself. Oftentimes, children don't pay attention to what we as adults think of as important. Recent research suggests that children, at the cost of reward, tend to explore more than adults do. While this behavior seems puzzling, it is not necessarily a bad thing. The current line of work tests the hypothesis that when children explore more, they notice things about the environment that adults do not. In Study 1 (24 6-12 yos, 24 adults), participants chose between 4 different monster characters for 80 trials. Halfway through the task, one monster changed how many stars it gave out (see figure). Children explored more than adults did. Consequentially, most children noticed this change while most adults did not. In Study 2 (100 3-12 yos, 48 adults), participants were instructed to remove items of a certain color from a container. Next, participants were shown 4 items: 2 items that were in the bin and 2 items that were not (see figure). While children did spend significantly more time exploring the bin than adults did, all participants regardless of age performed at chance. In summary, while this exploratory bias is present in both studies, it is only advantageous for children when the environment is changing.

4-B-30 Mechanisms underlying different sources of interference in recognition memory development - A computational modeling approach

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It has been known that recognition memory is affected by different sources of interference. For example, recognizing a past event such as whether you took your vitamins this morning could be confusing because of many other events that happened this morning (i.e., item noise), because of the many other times you took vitamins in the past (i.e., context noise), and/or even due to other events that happened in other times in your past (i.e., background noise). Previous research has shown that item noise rapidly decreases early in development (e.g., from 4yrs to 7yrs), while context noise gradually decreases throughout adulthood. On the other hand, it is not clear what kind of cognitive mechanisms are underlying these changes. In the current study, we examined the mechanisms underlying different recognition memory interference, especially regarding attention and vocabulary development. We tested 228 4-year-olds using a recognition memory task, which used words as stimuli, and decomposed the sources of interferences using a Bayesian computational model. Additionally, we administered 4 tasks in the NIH-toolbox (i.e., picture vocabulary, flanker, dimension change card sort (DCCS), and picture sequence memory tasks (PSMT)) to understand the mechanisms underlying different sources of interference. Results mainly show that item noise is closely related to the picture vocabulary task implying that confusability among items stems from one's receptive vocabulary size, whereas context noise is closely related to the flanker and DCCS tasks implying that confusability among different contexts stems from one's attentional ability (see Table 1).

C – Spatial and numerical knowledge

4-C-31 Number bias during categorization is driven by relative discriminability, not universal preference

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Recent work suggests that both human and non-human primates exhibit a spontaneous preference for numerical information when categorizing dot arrays (Anobile et al., 2019; Ferrigno et al., 2017). However, given a paucity of research on the perception of non-numerical magnitudes, it is unclear whether this preference reflects a universal bias towards number, or instead, reflects a more general bias towards the most perceptually discriminable dimension (Melara & Mounts, 1993). Replicating Ferrigno et al. (2017), we found that when number and cumulative area (CA) values were matched by ratio (such that CA was less discriminable, as determined by a separate magnitude comparison task), adults and children (6 - 8 years old) preferentially categorized dot arrays by numerical value. Critically, however, when number and CA values were perceptually matched (such that both dimensions were equally discriminable), adults and children no longer exhibited a preference for number, with no difference between the influence of number and CA on categorization. Taken together, these findings challenge recent claims that number is a uniquely fundamental or salient dimension, given that the putative number bias can be accounted for by differences in baseline discriminability.

4-C-32 Supporting children's fraction learning with manipulatives and gesture

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Fractions--their concepts, procedures, and symbolic notation--are well-known for the difficulty they present children, beginning in elementary school, and often, persisting long after. To illustrate, on the 2017 NAEP, only 32% of 4th-grade students were able to identify whether $1/3$, $2/3$, $2/6$, $4/6$, $2/8$, and $4/8$ were $<$, $=$ to, or $>$ $1/2$. This persistent difficulty with fractions has been theorized to stem from a whole number bias, whereby we extrapolate our whole number knowledge onto the concepts and procedures of fractions. In the U.S., children are introduced to fraction concepts in first and second grade through the area model. By teaching children how to partition a whole area into equal parts, fraction instruction builds on children's everyday experiences with sharing. However, if instruction disproportionately concentrates on the area model, children may encounter change-resistance, becoming further entrenched in the whole number bias. To reduce the impact of the whole number bias, researchers and curriculum developers encourage children's development of magnitude estimation skills. Action-Based Tools for Learning Mathematics: Manipulatives and Gestures Concrete manipulatives are fixtures in mathematics lessons, as they provide children with a concrete and embodied base from which to develop abstract ideas and concepts. Within the topic of fractions, a considerable body of work has investigated the efficacy of various manipulatives in promoting children's fraction learning. Gestures, on the other hand, have been relatively underutilized as an instructional tool for fraction learning; although they too have been associated with learning, albeit in other content areas. Overview The overarching question of the current study is: How can we mobilize the semiotic resources of object manipulation and gesture to facilitate children's development of flexible and robust fraction knowledge? To explore this issue, we conducted an experiment investigating the utility of concrete manipulatives, gesture, and their combination when introducing 2nd- and 3rd-grade children to fraction notation and magnitude estimation. Method We recruited 62 children for this study. Data were collected during the school year before children were formally introduced to fraction notation and number line-estimation tasks. The instructional session began with a pretest. Next, each child received instruction in 1 of 4 randomly assigned conditions: (1) manipulative based; (2) gesture based; (3) manipulative first then gesture; or (4) paper and pencil only. Immediately after instruction, children completed a posttest. Results Preliminary data suggest that the interventions promoted children's learning of number line-estimation: All conditions except for the manipulative-based lesson, led to learning. However, none of the experimental conditions led to generalization, as measured by children's performance on area-model estimation and fraction-magnitude comparison. Discussion By examining the effectiveness of these interventions, which focus on fraction partitioning and magnitude estimation, we aimed to leverage low-cost tools that can potentially enrich children's learning in all classrooms--in particular, those classrooms with few resources. Our findings contribute to understanding how these tools support--or constrain--the development of children's flexible and generalizable mathematics knowledge.

4-C-33 A conceptual framework for understanding fractions and fraction addition

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Learning fractions is a critical step in children's mathematical development. However, many children struggle with learning fractions, especially fraction arithmetic. We propose a framework for integrating understanding of individual fractions and fraction arithmetic, Putting Fractions Together (PFT). PFT (Figure 1) emphasizes that both individual fractions and sums of fractions are composed of unit fractions and can be represented by concatenating them (putting them together); for example, $3/7 + 1/10$ can be represented by concatenating three $1/7$ s and one $1/10$. We developed several computer-game-based

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interventions created based on the framework and tested these interventions in two experiments with fourth, fifth, and sixth grade children. The interventions led to improved performance on two tasks involving individual fractions (number line estimation and magnitude comparison) and on two fraction addition tasks (comparison of sums to 1 and estimation of sums). Especially large improvements were observed on relatively difficult unequal-denominator fraction sum problems (Cohen's d ranging from 1.25 to 1.40). The results suggest that viewing individual non-unit fractions and sums of fractions as concatenations of unit fractions provides a sound conceptual foundation for improving children's knowledge of both. The findings have implications for teaching and learning fractions, children's numerical development, and mathematics education in general.

4-C-34 Socioeconomic status moderates the relation between spatial and numerical skills in children

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Socioeconomic status (SES) is a strong predictor of differences in levels of children's spatial and numerical skills, but less is known about whether SES moderates the relation between spatial and numerical skills. Kindergarten to 4th graders ($N = 484$; 266 females) completed developmentally appropriate measures of mental transformation, approximate calculation, and exact calculation. Scores were standardized within grade-level. Demographics were self-reported by children's parents. Our primary measure of SES was a factor score combining parents' education and annual family income (Table 1). SES was a significant positive predictor of mental transformation, $\beta = 0.26$, $p < .001$, approximate calculation, $\beta = 0.14$, $p = .010$, and exact calculation, $\beta = 0.21$, $p < .001$. SES also moderated the relation between children's mental transformation skills and exact calculation skill, $b = .12$, $p = .021$. Higher-SES children showed a stronger relation between mental transformation and exact calculation skills than their lower-SES counterparts. This interaction was not significant for approximate calculation skills. We also explored whether a cumulative sociodemographic risk (SDR) score using additional demographic information (Table 1) would better predict these relations. Results were comparable to the SES measure, and SDR was not a significantly greater predictor than the SES factor score. In sum, SES predicts levels of spatial and numerical skills as well as the relations between some spatial and numerical skills. Future research should examine whether similar patterns of results emerge across developmental time.

4-C-35 Low-income mothers' and fathers' math talk during parent-child Play: A look at quantity and quality

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Introduction: Despite the importance of early math skills for later school success, the quantity and quality of the early environmental inputs children need to develop math skills has been somewhat neglected. Studies suggest that the variability in math skills (e.g. knowledge of numbers, spatial relations) observed at kindergarten reflect SES differences in the types of environmental inputs children are exposed to at home (Starkey et al., 2004). However, these studies are based on average differences, which can mask variability even within SES groups. Studies of language skills among low-income families document substantial variability in the quantity and quality of young children's language skills, suggesting that this might also be the case for math outcomes (Malin et al., 2014; Rowe et al., 2016). To

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date, there are virtually no studies on the types of parental inputs that target math skills that children in low-income families might experience. We address this gap by examining low-income parents' math talk directed at children at home. Research Questions/Hypotheses: We ask: (1) What is the frequency of math talk by mothers and fathers during infancy (9-months) and toddlerhood (18-months)? What is the quality (e.g., diversity) of math concepts used by mothers and fathers during infancy and toddlerhood? (2) Are there differences in math talk frequency and diversity between mothers and fathers? (3) Does math talk use vary by parents' education, home language, or math anxiety? Given the lack of guidance in the literature, we do not make specific hypothesis. Sample: Our sample includes 202 co-resident families, including mothers, fathers, and their child at 9 and 18 months of age who were participating in an ongoing, longitudinal parenting intervention. Most parents were Hispanic/Latino (68%) or Black (17%). There was also variability in parents' educational attainment ranging from less than high school to some college or greater. Method: We use video-recoded father- and mother-child dyads interacting in their homes during 25 minutes of free play. These interactions were coded for parents' spontaneous math talk using nine codes: 1) Cardinality, 2) Counting Objects, 3) Abstract Counting, 4) Ordinal and Equivalence Relations, 5) Spatial Relations, 6) Arithmetic, 7) Patterning, 8) Identifying Numerals, and 9) Shapes. Parents also completed surveys including information about their demographics, feelings of math anxiety, and other parenting practices. Analysis and Results: We will conduct descriptive analyses on the math talk variables and run a paired samples t-test to determine any significant differences between parents. We will run a multiple regression to determine whether mothers' and fathers' education, home language, and math anxiety contribute to parents' math talk. A preliminary analysis of the coding revealed variability in the frequency of math talk (11-43 occurrences/25 minutes) and the diversity of math concepts used (3-8 categories). Conclusion: This research examines low-income parents' math talk with their children, filling the gap in the literature on low-income parents' involvement in children's math development. Understanding these mechanisms may assist in the development of interventions focusing on improving key skills to reduce the disparities in math achievement among low-income children upon school entry.

4-C-36 Spatial abilities explain temporal monitoring of multiple tasks: Testing the spatio-temporal hypothesis in children

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Prior research in adults showed that spatial thinking contributes to multitasking performance (Mäntylä, 2013). We tested this spatiotemporal hypothesis for the first time in children between 8 and 12 years of age. In a newly developed touchscreen paradigm, children (N = 116) were asked to monitor up to four counters that ran at different paces, and to press a button whenever a counter had reached the end of its cycle. Children also solved two mental rotation tasks measuring dynamic spatial abilities, as well as two tasks assessing executive functions and visuo-spatial working memory. Regression analyses showed that a significant part of the variance in children's multitasking performance was explained by mental rotation, beyond age, executive functions, and visuo-spatial working memory. These results are the first to corroborate the spatiotemporal hypothesis in children and highlight the prominent role of spatial abilities in higher-order cognition, such as coordinating multiple tasks.

4-C-37 Contribution of executive function to individual differences in preschool children's spatial thinking

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Spatial thinking refers to a number of skills including the ability to understand size, shape, location, and direction/distance, to reorient and navigate in space, to use maps and diagrams, to mentally transform/rotate objects and to recreate patterns (Sinton et al., 2013). Individual differences in spatial thinking predict children's early math ability (Gunderson et al., 2012; Verdine et al., 2014) and later success in Science, Technology, Engineering, and Mathematics (STEM) disciplines (Wai et al., 2009; Lubinski, 2010). Individual differences in spatial thinking emerge as early as preschool and persist into adulthood (Levine et al., 2012, Hawes et al., 2015). For this reason, identifying factors that contribute to individual differences in spatial ability as early as possible is of the utmost importance. Many factors appear to explain individual differences in spatial thinking, including child and parent use of spatial language (Polinsky et al., 2017; Pruden et al., 2011; Pruden & Levine, 2017), child motor skill (Jansen & Heil, 2010; Lehmann et al., 2014), engagement in spatial play (Casey et al., 2008; Levine et al., 2012; Jirout & Newcombe, 2015) and spatial anxiety (Ramirez et al., 2012). There is reason to believe that executive function, or higher-order cognitive abilities involved in goal-planning and attainment, may be related to spatial thinking. Hyun and Luck (2007) proposed that working memory, specifically, is involved in the process of storing visual representations of stimuli while rotating it in one's imagination during mental rotation. Furthermore, working memory appears to predict mental rotation ability in children (Lehmann et al., 2014) and mediate sex differences in mental rotation tasks in adults (Kaufman, 2007). Less is known about the role that other components of executive function (e.g., inhibition, set-shifting) play in spatial thinking. We explore the contribution of multiple executive functions in explaining individual differences in spatial thinking. A total of 131 four- to six-year-olds ($M=60.73$ months, $SD=7.99$) were recruited from preschools in Miami, Florida and assessed using a battery of spatial (Spatial Scaling Test [SST], Children's Mental Transformation Test [CMTT], and WPPSI Block Design), executive function (NIH Toolbox Flanker and Dimensional Change Card Sort [DCCS], Corsi-Block Tapping, Digit and Word Span), and general intelligence tasks (NIH Toolbox Receptive Vocabulary and Processing Speed) throughout two 30-minute sessions. Results show that executive functions beyond just working memory significantly explained individual differences in spatial ability. For example, those tasks related to inhibition (Flanker), set-shifting (DCCS), and working memory (Corsi-Block, Digit and Word Span) significantly predicted individual differences on SST ($b=-0.52$, $t=-4.37$, $p<.001$; $b=-0.29$, $t=-3.00$, $p=.003$; $b=-.4.90$, $t=-2.30$, $p=.02$, respectively). Set-shifting ability (DCCS) and working memory (Corsi-Block, Digit and Word Span) significantly predicted individual differences on CMTT ($b=0.03$, $t=1.95$, $p=.05$; $b=0.87$, $t=2.56$, $p=.01$, respectively). No associations between any of the executive function tasks and Block Design were found (lowest p -value=.09). All results held when we controlled for Receptive Vocabulary, Processing Speed, child age and SES. These results offer a promising route for future spatial thinking interventions whereby executive functions are trained with the aim of improving spatial ability

4-C-38 Unscientific conceptions about sunrise and sunset: Gestures matter, too

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Many children hold misconceptions about the day/night cycle (e.g., that the Sun moves), even after instruction (Plummer, 2009). After learning that the Sun's apparent motion is caused by Earth's rotation (Jee & Anggoro, in press), third graders ($N=85$) improved in their verbal explanations of Sunrise and Sunset, but these explanations remained incomplete (out of 3 possible points, $MSunrise=1.61$ points, $SD=.64$; $MSunset=1.73$ points, $SD=.59$). Interestingly, children scored higher ($M=2.28$ points, $SD=.78$) when explaining the cause of the day/night cycle than for Sunrise ($p<.01$) and Sunset ($p<.01$), $F(2, 168) = 22.78$, $p<.01$. Children's gestures may provide insight into why the Sunrise and Sunset concepts seem relatively resistant to change. At pretest, children made more movement gestures (i.e., vertical hand motion referencing the Sun's movement) than rotation gestures (i.e., circular hand motion referencing Earth's rotation) in their explanations for both Sunrise ($t(84)=-3.62$, $p=.01$) and Sunset ($t(84)=-3.96$, $p<.01$). At posttest, children continued to make more movement gestures than rotation gestures for Sunrise, $t(84)=-1.99$, $p<.05$, but did not differ significantly in their use of movement or rotation gestures for Sunset. In contrast, for Cause, children consistently used more rotation than movement gestures at both pre- ($t(84) = 4.27$, $p<.01$) and posttest ($t(84) = 3.31$, $p=.01$). Language, perceptual experiences, and gestures may be potential contributors to children's conceptions.

4-C-39 Context effects in children's numerical and temporal estimation

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Studies have revealed robust central tendency biases in human timing, such that temporal estimates are biased toward the mean of values presented resulting in: (1) slopes relating estimates to actual values being consistently <1 ; and (2) context effects, in which values are estimated as longer or shorter depending upon the temporal context (e.g., a stimulus lasting 1800 ms is estimated as shorter when presented in the context of other durations ranging from 1000-2000 ms than in a 1600-2600 ms context). These biases have been taken as evidence that magnitude estimation is subject to Bayesian processes (Jazayeri & Shadlen, 2010). Here, we investigate whether similar biases are observed in 7-12 year old children for temporal estimates (Study 1; $N=130$) and in a novel quantitative domain, numerical estimation (Study 2; $N=114$). Analyses reveal slopes relating temporal and numerical estimates to the actual values presented were both significantly less than one ($p's<.001$), coupled with consistent context effects in both tasks ($p's<.01$). Critically, however, numerical context effects were in the opposite direction of those for time (Figure 1) such that values were estimated as larger when presented within the smaller context. These findings are the first to demonstrate context effects in childhood and in numerical estimates, while also suggesting that current models of estimation biases may not fully account for context effects found in all quantitative estimation data.

4-C-40 Children's understanding of quantitative relations across stimulus formats

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Children's understanding of math language predicts their math ability (Purpura & Reid, 2016). An open question is how knowledge of specific terms varies across quantity representations. We examine 4-7-year-olds' understanding of terms for size, magnitude, and order when quantities are areas, discrete sets, or numerals. We asked children which of two quantities "is bigger/smaller (BgSm)?", "is more/less (MoLe)?", or "comes after/before (AfBe)?". Preliminary analyses ($N=93$; pre-registered sample=150) reveal differences across terms and stimulus format. For both Area and Discrete Sets, children perform

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best on BgSm, 96/94%, followed by MoLe, 88/88%, and AfBe, 54/64% ($p < 0.05$). For Numerals, children do not significantly differ on BgSm, 91%, and MoLe, 86%, but perform worse on AfBe, 78% ($p < 0.05$). Across formats, children perform similarly on BgSm and MoLe; but, on AfBe, children perform significantly better with Numerals vs Area, with Discrete Sets in between. Overall, the order of performance with different terms is the same across format, suggesting some flexibility in thinking about these terms across contexts. In all formats, children performed lowest on ordinal terms (relative to size or magnitude). This suggests that children have difficulty seeing how numerical order reflects magnitude/size. However, this is less extreme for numerals, suggesting a context-dependent emergence of this understanding.

4-C-41 Links between young children's spatial and language skills: Coding relative proximity to a landmark

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This investigation examined whether children use verbal or nonverbal strategies to code the relative proximity of two objects to a landmark in a memory task. Two- to 2.5-year-olds watched an experimenter hide two different toys in two identical containers placed 2 and 12 inches from a landmark. The experimenter described the hiding locations with neutral (e.g., here; Experiment 1) or spatial (e.g., close/far; Experiment 2) labels. After hiding, children were carried outside the enclosure to a new viewpoint and then looked for a target toy. Experiment 2 also included language measures: parent reports of children's general and relational vocabularies, and performance on a language task, which tested comprehension of spatial and color terms. Children's performance in the memory task was significantly above chance, but hearing spatial labels during hiding did not improve performance relative to hearing neutral labels. We also found that children's productive relational vocabulary predicted memory task performance and that children's comprehension of color (but not spatial) terms in the language task was the strongest overall predictor of memory task performance (Figure 1). These results suggest that at young ages, children rely on a nonverbal strategy when coding relative proximity to a landmark in a memory task and that young children who are better at forming abstract categories (like colors) may code relative proximity more successfully.

4-C-42 Verbal and nonverbal mismatch: An indication that a child is transitioning towards a better understanding of fractions

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Prior research on mathematics learning suggests that children who produce mismatches in verbal and nonverbal communication are more susceptible to improve through instruction than other students (e.g., students whose verbal and nonverbal behavior match). In the current study, we extend this research, which previously examined topics such as mathematical equivalence, to fractions. Video-recorded interviews were conducted with 21 children ages 7-10 to assess their understanding of fractions. We examined whether correct fraction understanding was consistently expressed in children's verbal and nonverbal (i.e., gestural) explanations. In addition, children were given a 14-item diagnostic worksheet to assess their existing knowledge of fractions, and based on their scores, children were assigned to a "High" or "Low" group. A preliminary analysis of all participants found that

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60% of children expressed correct and consistent understanding in both speech and gesture, whereas 40% of children conveyed correct understanding in gesture but incorrect understanding in speech. "High" level children consisted mostly of "correct matchers" (e.g., speech and nonverbal expressions matched and were correct). "Low" level children consisted mostly of mismatchers (e.g., their speech was incorrect but their gesture was correct). These results support previous research, suggesting that children who display inconsistencies in their speech and gesture may be transitioning toward advanced fraction understanding.

4-C-43 U-shaped development of spontaneous counting on tasks designed to assess children's number word knowledge

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Children's spontaneous counting is positively associated with performance on tasks measuring understanding of cardinality (LeCorre et al., 2006; Posid & Cordes, 2018), such as give-n and "what's on this card" (WOC). However, prior work examining this association have included few children at low knower levels. In our work with a diverse group of preschoolers (N = 309), we noticed many pre-knowers and one-knowers spontaneously counting. Exploratory graphical analysis suggested a curvilinear association between knower level (0-5) and spontaneous counting (yes/no). To test this, a squared version of the knower level variable was entered sequentially into a logistic regression predicting the log odds of counting on the task. The control model included age and counting skill. On give-n, the linear knower level term accounted for significant improvement in the model (from -2LL=340.82 to -2LL=303.48, chi-square[1]=37.34, $p<.001$). Greater knower level was associated with increased probability of counting ($b=.56$, $SE=.10$, $p<.001$). When the quadratic term was entered, there was further improvement to 293.49, chi-square[1]=9.99, $p=.002$. Similar evidence for a curvilinear association was also found on WOC (-2LL from 401.03 to 382.12, chi-square[1]=18.92, $p<.001$). Spontaneous counting may be common at the start of learning, but then declines as children begin to connect the number words to specific set sizes, before increasing again as children near an understanding of the cardinality principle.

4-C-44 Drawing and two-digit numeral learning: An exploration of recognition accuracy and the errors made by preschoolers

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Differences in foundational math skills (e.g., numeral recognition) can be observed as early as preschool and lead to lower high school math performance (Duncan et al., 2007). Drawing during number learning may improve preschool numeral recognition by deepening encoding and increasing retrieval opportunities (Paivo, 1971; Van Meter & Garner, 2005). We examined two-digit numeral recognition in 77 preschoolers, comparing tracing to looking. The tracing group made fewer errors than the looking group at post-test ($p=.028$). Using Bonferroni's correction, post-test accuracy was above chance (25%) in the tracing group ($M=40.69\%$, $p<.001$), but not the looking group ($M=31.11\%$, $p=.073$). Examination of errors revealed that the tracing group was more likely to choose the inverse of the correct numeral (e.g. 36 versus 63) than the looking group ($p=.011$). This indicates that drawing does deepen processing and affect numeral recognition in preschoolers, as it reduces errors and promotes above-chance recognition accuracy for two-digit numerals.

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4-C-45 Two-year-olds' symbolic use of images provided by a tablet. A transfer study

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Touch screen devices are nowadays present in everyday life. Parents and educators assume that very young children understand that their images represent entities of the real world and, consequently, can be used as symbols and as learning tools. In two studies, we investigated 2-year-old children's use of images on a tablet in two symbolic tasks: as sources of information (Search) and as means of communication (Point). Contrary to most studies that used printed or video images, the results showed that 2-year-olds successfully used the images on a tablet as sources of information but not as means of communication. We also carried out a transfer study comparing the performance of an Experimental (Search-Point) and a Control group (Point-Point). We found that the Experimental group outperformed the Control group, and that the successful symbolic previous experience gained in the Search tasks was transferred to the Point task, task which two-year-olds otherwise fail.

4-C-46 Touchscreens and spatial thinking: Exploring the connection between children's spatial skills and their performance on a spatially-oriented touchscreen game

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Touchscreens' affordances may facilitate unique learning experiences. For example, touchscreens may be ideal for spatial learning because they are inherently visuospatial and allow users to manipulate shapes in ways that highlight spatial relations. Given the ubiquity of touchscreens in children's lives and that spatial skills are predictive of children's STEM success (Shea et al., 2001), exploring the link between spatial learning and touchscreens is valuable. Thus, this study investigated the connection between children's spatial skills and their performance on Relationshapes, a spatially-oriented touchscreen game. During Relationshapes children complete consecutive levels in which they create shape constructions that match a presented model. Relationshapes performance was measured by the average speed of level completion. The 2D and 3D Test of Spatial Abilities and the Children's Mental Transformation Task (Levine et al., 1999; Verdine et al., 2014) were used to assess spatial skills. Performance on Relationshapes improved with age $r(53) = .65$, $p < .0001$, showing that the game was most challenging for younger children. The key role of spatial skills was illustrated by an age by spatial abilities interaction, $p = .015$, in which younger children with high spatial skills performed more similarly to older children than younger children with low spatial skills. This reflects literature suggesting that spatial skills are particularly valuable for problem solving and learning in challenging and novel situations (Uttal & Cohen, 2012).

4-C-47 The effects of pattern training on pre-algebraic thinking in preschoolers

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The ability to recognize patterns early in development is predictive of later math skills. Although some of the factors facilitating pattern learning have been identified, whether the spacing of that early training on learning and retention remains unknown. Four-to six-year olds ($N=53$) were presented with a match-to-sample pattern task, in which they were shown an exemplar and asked to choose from either a pattern- or perceptual-choice match. Using a basic pre-post design, children were trained via one of two

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conditions: Spaced ($n=29$; pattern task taught in blocks with spaced breaks) or Massed ($n=24$; pattern task taught through one straight session); Figure 1. Children completed pretest, training, and posttest in a single session, then completed posttest trials again following a two-week delay. Following either type of training, 4-year-olds continued to pick the perceptual match ($p>.3$), while 6-year-olds immediately and robustly picked the pattern match at near-ceiling levels ($p<.04$). 5-year-olds benefited from Spaced training over Massed training, selecting the pattern match following Spaced training ($p=.009$), which held during posttest in session 1 ($p=.073$) and following a two-week delay ($p=.008$). 5-year-olds trained in the Massed condition continued to pick at chance level (50%; $p>.5$). These results suggest the potential benefit of spaced practice or training on pattern and pre-algebraic learning in the classroom and has implications for curricular development.

4-C-48 Children's and adults' math attitudes are differentiated by number type

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Among both children and adults, math attitudes predict important cognitive outcomes such as learning and performance (e.g., Cooper et al., 2018). Based on research in math cognition (e.g., Van Hoof et al., 2015) demonstrating that both children and adults sometimes fail to treat whole numbers and fractions as part of an integrated system of mathematics when reasoning (see Siegler et al., 2011), we examined whether their attitudes also reflect differentiated number concepts. Across four studies ($N = 119$; $N = 371$; $N = 76$; $N = 76$), we found that children and adults have different attitudes about mathematics when asked specifically about whole numbers vs. fractions, p -values $< .001$, Cohen's d ranged from -1.22 to -0.84 . The vast majority (69% - 88% across studies) of children and adults reported negative attitudes towards fractions despite positive attitudes towards whole numbers. Their attitudes towards "math in general" were more closely aligned with attitudes towards whole numbers, suggesting the centrality of whole numbers to people's general concept of "math". These findings may have important implications for how children and adults conceptualize number categories and engage with numerical information (e.g., in a classroom or medical setting) when presented as fractions.

4-C-49 Effects of set size on cumulative area judgments in young children

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There is an enduring debate over the relative salience of continuous and discrete quantities. While some theorists argue that children rely upon continuous features when tracking number (Clearfield & Mix, 1999; Leibovich et al., 2017), less work has explored whether children are able to track continuous quantities in the presence of numerical information. In the present study, we tested children's (3-6 year olds; $N=48$) abilities to track the cumulative area of sets of items, specifically investigating how set size may impact their abilities to do so. Participants were presented with pairs of images containing single, small (2 or 3 items), and large (10 or 15 items) sets of irregular shapes and were asked to indicate the picture containing the greater total area. Children performed above chance on both single and multiple item arrays ($p's > .01$), but performance was significantly better when tracking the area of a single item ($M=83.1\%$) compared to multiple items (small sets $M=74.1\%$; large sets $M=76.6\%$; $p<.05$). Notably, set size did not impact cumulative area judgments of multiple items; children performed comparably on small and large sets ($p>.1$), contrary to previous findings with adults (Savelkoul & Cordes, submitted). Numerical information did matter, however, such that children performed worse on incongruent trials --

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in which the set size with the larger cumulative area had the smaller number of items -- than on trials in which number was not in conflict ($p's > .05$). Overall, findings suggest that children are able to track cumulative area of sets, but they may invoke distinct strategies than that of adults. Future work will test alternative explanations.

4-C-50 Teaching shortcuts before complex strategies improves flexibility in mathematical equivalence problem solving

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In U.S. schools, mathematics instruction typically focuses on complex methods that work for every problem, and spends little time on possible conceptual shortcuts. Students also demonstrate limited ability to solve problems in multiple ways or to select the most efficient strategy to solve problems. We examined whether altering strategy instruction increases flexibility on mathematical equivalence problem-solving. Undergraduates (Exp. 1; $N=58$) and second- and third-grade children (Exp. 2; $N=54$) were randomly assigned to complex-first or shortcut-first conditions. In the complex-first condition, students received instruction and practice on a multi-step procedure that worked for all problems. Then, they were instructed on a more efficient conceptual shortcut strategy that did not work on every problem. Students in the shortcut-first condition received instruction on the shortcut followed by the complex strategy. At posttest, undergraduates showed no significant differences between conditions on conceptual, procedural, or flexibility knowledge subscales. However, undergraduates in the shortcut-first condition flexibly used the shortcut strategy more. Children in the shortcut-first condition showed significantly higher procedural knowledge, transfer, and flexible use of the shortcut, but not higher conceptual or flexibility knowledge. Teaching conceptual shortcut strategies first may reduce entrenchment and support flexible thinking about mathematics.

4-C-51 Learning through seeing versus doing: Exploring the best way to teach mathematical equivalence

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Literature suggests that learning through self-produced movement is more effective than learning through observed movement (e.g., James & Swain, 2011). Here, we considered how self-produced versus observed movement strategies help 9-10-year-old children ($N=145$) correctly solve mathematical equivalence problems during instruction as well as up to a month after, and across trained and transfer problem-types. We also considered two forms of movement used in the classroom: action - movements used to manipulate objects, and gesture - movements that express meaning and often accompany speech. Children were more likely to generalize and retain their knowledge across a 1-month delay if they produced either movement strategy (Figure 1b), suggesting that producing a movement strategy leads to long-lasting, flexible knowledge. However, results suggest that during instruction itself, children learned more quickly when observing a movement strategy during instruction ($p < .05$) (Figure 1a). These findings have implications for understanding nuances of how children benefit from different types of movement at different time points.

4-C-52 Advanced fraction understanding requires knowledge expressed across multiple representations

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Previous literature shows that developing conceptual understanding of fractions is critical to obtain flexibility in mathematics and to achieve higher academic success. Theories about the development of mathematical knowledge suggest that complex understanding of fractions requires flexible linking of multiple representations. The goal of this research was to identify and describe the consistency of children's understanding of fractions through use of different concrete manipulatives (e.g., fraction circles and number lines) obtained through a structured, open-ended interview. In the interview, 21 7 to 10-year-old children were asked to show and explain the meaning of certain fractions. In addition, children individually completed a 14-item diagnostic worksheet and, based on this assessment, were categorized as having low- or high-fraction knowledge. The types of concrete manipulatives children used during the interview to express their fraction knowledge were examined. Results showed that high-fraction knowledge was associated with expressing correct fraction understanding consistently across multiple manipulatives whereas low-fraction knowledge was associated with expressing both correct and incorrect understanding inconsistently across manipulatives. These results suggest the need to develop instruction that facilitates linkages across multiple models to support children's development of flexible linking in mathematics.

D - Linguistic and conceptual development

4-D-53 The ability to remember a novel word is related to mutual exclusivity ability in children with Down syndrome

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The current research investigated the ability to learn and remember new words through mutual exclusivity (ME) and shape bias (SB) of children with Down syndrome (DS). Children with DS ($M = 3.3$ years, $SD = 1.1$) and typically developing (TD) children ($M = 3.2$, $SD = 0.5$) matched by verbal mental age participated in this study. Children performed a preferential looking (PL) task comprised of 24 trials equally divided into three phases: training, ME, SB. Five minutes later, to measure their word learning, children participated in 8 four-alternative forced choice trials. To examine children's performance in the PL task, we performed a mixed measures ANOVA with Naming (pre-naming, post-naming) and Trial (training, ME, SB) as within-subject factors and Group as between-subjects factor using the proportion of target looking (PTL) as the dependent variable. Results showed an interaction between Naming and Trial ($F(2,66) = 9.83$, $p = 0.001$), but no effect of Group or other interaction. Pairwise comparisons between the pre and post-naming revealed that both groups looked more to the target in the post-naming phase of the training ($p = 0.001$) and ME ($p = 0.007$) trials, and it was marginally significant in SB trials ($p = .08$). Also, correlations between remembered words (RW) -number of objects correctly identified in the learning trials- and the PTL in each trial type indicated that RW was related with SB ($r = 0.55$, $p = 0.20$) in TD, and it was related to ME ($r = 0.66$, $p = 0.002$) in DS. Overall, these results suggest that children with DS are capable to assign new labels to a new object, but maybe they have difficulties to extend this label to other objects with the same shape features.

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4-D-54 Tuned in: Children learn from overheard speech while engaged in a cognitively demanding task

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The present study investigates whether 3 to 5-year-old children can learn from overheard speech while engaged in a cognitively demanding task. Previous investigations surrounding the role of overheard speech have focused primarily on learning novel words and object names from very simplified language, typically while the child plays with a toy or is engaged with an object that relates to the overheard conversation. Our study design instead resembled the context of a classroom or a home in which children are likely to be occupied with a demanding, unrelated task while overhearing other conversations. Specifically, children ($n = 25$; $M = 4.48$ years) played a cognitively demanding matching game while they overheard a confederate tell the researcher about an unrelated storybook. Next, children were given the wordless storybook--which visually depicted some but not all of the information relayed by the confederate--and then answered a series of questions about the book. Children learned character names ($p = 0.045$) and facts ($p = 0.009$) that could only have been learned through overhearing above chance (0.5), but did not reliably learn new words ($p = 0.265$). Interestingly, children who were more engaged with the matching game--as indexed by the number of card pairs that they found--were no less likely to learn from overhearing. These findings suggest that preschoolers can learn from conversations in their surrounding environment even when distracted by a challenging activity.

4-D-55 Bridges versus barriers: Do incorrect theory-like intuitions help or hinder learning about counterintuitive scientific concepts?

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The structure of children's intuitive scientific knowledge is debated. Some argue intuitive explanations resemble coherent theories (e.g., Vosniadou, 2002) and others argue they resemble sets of fragmented ideas (e.g., "pieces of knowledge," diSessa, 2008). We investigated the degree to which children's explanations of the counterintuitive concept of natural selection (NS) resemble coherent theories and whether children who give theory-like explanations are more or less likely to learn. On one hand, theory-like explanations may be more entrenched than fragmented explanations. On the other, coherent theories might offer a better representational basis from which to process a counterintuitive refutation. At pretest, 220 2nd and 3rd graders explained how animals come to have specialized traits. They then listened to a storybook on NS, performed a simulation activity, and completed a measure of NS understanding. Pretests from a preliminary sample of 79 children were coded. 48 were codeable and fully incorrect. Of these, 32 (67%) provided a coherent, theory-like explanation (i.e., described a single mechanism), but only 16 (33%) provided an incoherent explanation (i.e., multiple mechanisms or no mechanism). Only 56% of the children who gave coherent explanations learned the fundamentals of NS. In contrast, 69% of the children who gave incoherent explanations learned. While this trend is non-significant, $p = .41$, analyses of the full dataset are ongoing. In sum, even in elementary school, most children's misconceptions about NS are classifiable as coherent rather than fragmented. Furthermore, coherent explanations show signs of impeding learning rather than acting as a bridge.

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4-D-56 Ecological thinking in preschoolers: Evidence from free play

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Free-play observation can provide insight into the way that preschoolers think about ecology. This study investigated the effects of priming taxonomic and ecological relations on sequential interactions with ecologically relevant toys. Preschoolers were videotaped playing with realistic toys representing mammals, birds, and trees from arctic, forest, and savannah ecosystems represented by realistic dioramas (figs 1 and 2). Prior to play, toys were introduced in either taxonomic or ecological groups to prime the respective relations, or random order (control). Sessions were coded for relations between sequentially manipulated toys (taxonomic, ecological, unrelated). Overall, children were more likely to interact with related toys in sequence than expected by chance. The ecologically primed group showed more ecological sequences and fewer taxonomic and unrelated sequences than the control group (fig 3). Taxonomically-primed and control groups did not differ. Results suggest that preschoolers may have an inherent taxonomic bias in thinking about relations among living things, but that attention can be shifted to ecological relations. More generally, the results indicate that even in an unstructured play setting, children interact with toys in a way that reveals their systematic conceptions of the world.

4-D-57 Relations between children's causal stance and emergent scientific literacy

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Interests and skills often co-develop within academic domains. Here, we ask whether this is also true in the context of emergent scientific literacy. Specifically, we ask whether preschooler's interest in causal information relates to their early scientific knowledge and skills? To address this question, we recruited 153 children from diverse backgrounds (30% Hispanic/Latino, 13% African-American; 28% mothers with no more than a high school degree) to complete a standardized measure of scientific literacy (Lens on Science, Greenfield et al, 2009), as well as inquiry or preference-based measures of their 'causal stance,' at both 3- and 4-years of age (Alvarez & Booth, 2016). Children's causal stance at 3-years predicted both contemporaneous and subsequent scientific literacy scores, the latter even after controlling for both children's exposure to science in the home and their language and cognitive skills (as measures by the NIH Toolbox Early Cognition Battery). In contrast, scientific literacy scores at 3-years of age did not predict 4-year-old causal stance scores. These results suggest that very early interests might drive skill and knowledge in the domain of science more so than skills drive interests.

4-D-58 When cues compete: How children reconcile conflicts between linguistic and social cues

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During word learning, children not only utilize linguistic heuristics like mutual exclusivity (ME; the assumption that one object only has one label), but are also exposed to a variety of socio-pragmatic (SP; looking, pointing) cues that aid in the word-learning process. The relative weight that children give to these cues is a topic of ongoing debate, with some work suggesting that children prioritize SP cues over ME (Grassmann & Tomasello, 2010). We examined how 15- to 49-month-old monolinguals resolve conflicts between ME and SP cues when instructed to retrieve one of two objects (one known and one

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novel). A researcher gave a strong SP cue (i.e., looking and pointing) to the known object while calling it by a novel name, or vice versa (i.e., pairing the known label with the novel object). Subsequently, a second researcher entered the room and uttered the same label while requesting an object, but without giving any SP cues. While we replicated previous findings that children favor SP cues over ME during the first act of labeling, their willingness to override ME was context-dependent: the majority of children who followed the SP cue with the first researcher behaved consistently with ME with the second researcher. In contrast to previous work, this suggests that conflicting SP information does not alter children's use of ME or their existing knowledge of word-object pairings; instead, children use SP cues to reason about specific pairings relative to a specific social agent.

4-D-59 Gestures and shared intentionality in the transition into language

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The transition into language is accompanied by a range of social-cognitive changes. One of these developments is a desire to share one's experiences with another person, which has been described as a core component of human language (e.g., Tomasello, 2007). Children's gestures may provide cues to this communicative advance, as when children begin to produce declarative points that call another person's attention to something in the environment. If this desire to share experiences with others is fundamental to language, we would expect that gestures that support that goal (i.e., declarative pointing) will be stronger predictors of subsequent language development than gestures that have more self-oriented communicative goals, such as pointing to request (i.e., imperative pointing) or reaching. We explored relations between different types of gestures and children's vocabulary development in children transitioning into language. Participants were 35 middle to upper-middle class typically developing children (26 girls) in Brazil who were visited at their homes at 9, 13 and 18 months of age. At each visit, they were administered Mundy et al.'s (2003) Early Social Communication Scales (ESCS). In addition, their mothers were asked to indicate the words in the Communicative Development Inventory (Fenson et al., 1994) that their children could produce spontaneously. The administration of the ESCS was video recorded for posterior coding of infants' verbalizations (single words and word combinations), and pointing and reaching gestures. Following ESCS's criteria, pointing, defined as an extension of the index finger towards an object or event, was coded as either declarative or imperative. Reaching was defined as an extension of one or both hands towards an object or event accompanied by a forward movement of the trunk. Although both pointing and reaching increased significantly throughout the study, they did not correlate significantly with one another. Reaching occurred more frequently than declarative or imperative pointing at all ages. This was particularly true of the first visit. In fact, while 34 of the 35 infants reached towards an object at least once at 9 months of age, only 6 pointed to show and/or to request at that age. Consequently, we focused on the 13 and 18 month sessions in our analyses of relations between children's gestures and their vocabulary development. Results showed that declarative pointing predicted both 13 month (Wald = 4.40, $p < .05$) and 18 month vocabulary (Wald = 6.87, $p < .01$), after taking into account maternal education and children's ESCS verbalizations at 13 months. In contrast, comparable analyses revealed that neither imperative pointing nor reaching predicted vocabulary development either concurrently or longitudinally. The finding that declarative pointing, but not imperative pointing or reaching, predicts subsequent vocabulary development aligns with the view that declarative pointing signals the acquisition of a key precursor for language. In

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particular, consistent with Tomasello's (2007) account, a developing desire for sharing intentions may underlie both declarative pointing and language learning.

4-D-60 Can chimpanzees, capuchin monkeys and children form abstract rules from minimal input?

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We developed an ecologically valid paradigm for testing abstract concept formation in chimpanzees (*Pan troglodytes*, $n=30$; within subject design), capuchin monkeys (*Sapajus* spp., $n=22$; within subject design) and 3-5-year-old human children ($n=212$; between subjects designs). In the evidence phase, participants sampled 5-10 items from each of four containers, either supporting the abstract concept that containers were uniform (containing either all high or all low value items) or mixed (with 50/50 high and low value types). Participants were then presented with two new containers which were both filled with only low-valued items. If participants had learned the abstract concept governing containers, then in the uniform condition one item is sufficient to predict the content of the first box (all low-valued type), and participants should quickly switch to the second box. In contrast, in the mixed condition more persistence at the first box is expected, as there is still a chance of finding high-valued rewards. Children switched to the second test box earlier in the uniform compared to the mixed condition, $F(1,206) = 12.00$, $p < 0.001$, consistent with abstract knowledge formation. Chimpanzees showed this pattern in just one of three presentation versions (apparatus; $t(20) = 2.64$, $p = 0.011$; cups: $t(28) = -0.32$, $p = 0.75$; foraging: $t(26) = 0.33$, $p = 0.74$), and capuchin's switching behaviour never differed between conditions (apparatus; $t(14) = -0.064$, $p = 0.95$; cups: $t(18) = -0.53$, $p = 0.63$; foraging: $t(20) = -1.63$, $p = 0.12$). Overall, the results suggest possible rapid evolutionary changes in abstract concept formation but also raise questions of human uniqueness.

4-D-61 The same or different? The effect of physical transformations on category membership of foods and non-foods

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Much of the research in children's categorization strategies has focused on natural kinds and human-made artifacts, but little of this has been specific to foods. Foods are unique in that category members are both natural and processed (human-made), have a history of human intervention and satisfy the function of being fit for human consumption. This research examines the effect of transformations on artifacts, non-food natural kinds, and natural and processed foods. Ninety-four preschoolers, kindergartners, and adults viewed 3 pictures of each of item: 1) original state, 2) process of being cut or crushed and 3) transformed state (e.g., whole apple, knife over apple, sliced apple). Participants were asked whether the transformed item was part of the original category or not (e.g., "Is this an apple or not an apple?"). A 3 (age) x 2 (transformation) x 4 (item) ANOVA revealed an Item x Age, $F(6, 273) = 4.75$, $p < .001$, and a Transformation x Age interaction, $F(2, 91) = 9.60$, $p < .001$. Follow up tests revealed participants were more likely to consider foods as part of the same category after the transformation as compared to non-foods, though this increased with age. In addition, older age groups were more likely

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to consider crushed items as part of the same category as compared to the younger ones. These results suggest that the criteria that determines when foods are no longer part of their original category develops with age and foods are reasoned about differently than non-food natural kinds and artifacts.

4-D-62 How correcting generic statements about gender limits kind-beliefs

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Generic statements (e.g., "Girls hate math") are a powerful vehicle for communicating kind-beliefs (Gelman, Ware, & Kleinberg, 2010; Rhodes, Leslie, & Tworek, 2012) common in parent-child conversations about gender (Gelman, Taylor, & Nguyen, 2004). The current study (N = 245, 4-7 year-olds) tested the proposal that responding to children's generic statements about gender by shifting focus to specific individuals can help limit children's beliefs that gender determines what people can do. Children saw an animated parent-child conversation, with generic statements about gender (e.g., "Girls are good at riding bikes") uttered by a child, each followed by a response from a parent character. Participants who heard the parent correct the generics by limiting their scope to a single individual (e.g., "Anna is good at riding bikes") had lower levels of kind-beliefs (M = 0.25, 95% CI [0.17-0.36]) than those who heard the parent affirm each generic (e.g., "Yes, girls are good at riding bikes"; M = 0.36, 95% CI [0.25-0.48]; p = 0.01); correcting the generic form by broadening it to the superordinate, non-gendered category (e.g., "Kids are good at riding bikes") led to intermediate levels of kind-beliefs (M = 0.31, 95% CI [0.21-0.44]; pairwise to Generic, p = 0.59; pairwise to Specific, p = 0.28). These effects were more pronounced with age (age x condition interaction, p = 0.03). Thus, correcting generics about gender to refer to specific individuals can help limit stereotyping.

4-D-63 Complexity of higher-order thinking in narrative and non-narrative talk

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Personal narrative is decontextualized talk where individuals recount stories of personal experiences about past or future events. Previous research suggests that the quality and quantity of narrative speech that parents use with children relates to their later academic outcomes (Dickinson & Tabors, 2001; Demir et al., 2015), possibly due to narrative's ability to promote emergent literacy (McCabe & Peterson, 1991) and/or academic language (Uccelli, et al., 2018). Our previous work suggests that narrative's importance in early parent-child conversations may also result from its ability to promote higher-order thinking (HOT) (Frausel, 2018; Frausel, et al., in prep). Higher-order thinking is a type of relational language where two representations are linked together, through inferences, comparisons, abstractions, and hierarchies (e.g. Richland & Simms, 2015). In this paper, we expand on this work to examine whether early personal narrative talk is particularly conducive at supporting the use of deeper structure-level HOT, where relationships between representations are more abstract and less easy to perceive. Structure HOT stands in contrast to simpler surface-level HOT, where relationships between representations are more immediate and easily perceptible. Usage of surface- and structure-level HOT in narrative and non-narrative contexts is examined in a longitudinal dataset of 64 children and their primary caregiver(s). Families were visited every 4 months between 14 and 58 months, and 90-minute spontaneous parent-child interactions were recorded. Speech from over one thousand hours of video was transcribed, resulting in a corpus of more than one million utterances. These utterances were coded for personal narrative and surface- and structure-level HOT. We found that as children develop, parents

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and children use structure-level higher-order thinking increasingly more frequently. At 14-months, only 22% of parents' HOT utterances in non-narrative contexts were structure-level, which increased to 38% by 58 months. Children use structure-level higher-order thinking less frequently than their parents, with structure HOT talk beginning to emerge with some regularity in around 34 months. At this age, 14% of children's HOT utterances in non-narrative were structure, which increased to 24% by 58 months. Although usage of structure HOT was relatively infrequent in non-narrative talk, it was overrepresented in personal narrative talk. For parents at every session between 14-58 months, more than 46% of HOT utterances in narrative contexts were structure (range 46-62%). This is higher than the baseline rate for structure HOT use in non-narrative contexts, even in their most mature state at 58-months. Children's narrative utterances also contained relatively more structure-level HOT compared to their non-narrative utterances, though overall patterns were weaker. At 34 months, 30% of HOT utterances in narrative were structure, which increased to 38% at 58 months. These findings suggest that parents and children may find it easier to embed deeper structure-level higher-order thinking in a narrative of personal experience, possibly due to narrative's self-relevance and saliency. Theoretically, these findings enhance our understanding of the nature of narrative and higher-order thinking. Practically, these findings can be leveraged in interventions with parents that seek to improve the quality of children's early language environments.

4-D-64 Incremental hypothesis revision in child and adult causal reasoning

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We investigated whether adults' and children's learning strategies when presented with one of two unusual patterns of cause and effect evidence are consistent with an 'exploitative' process of incremental hypothesis revision. Adults and children were presented with a series of blocks that did or did not activate a machine. Although the criteria for activation initially seems to fit a simple, highly salient rule (e.g., 'blocks with a blue background' activate the machine), this rule failed to explain all of the data (e.g., some blocks with red backgrounds also activate the machine). In one condition (the 'near' condition) the true rule could be discovered through a process of iterative hypothesis revision, while in another condition (the 'distant' condition) reaching the true rule requires dismissing the naive rule entirely (the true rule does not involve the background at all). Adults (N = 90) were better at predicting which blocks would activate the machine in the near condition than in the distant condition ($p < 0.01$, $\chi^2 = 7.4812$, $MSE = 0.13$), consistent with an exploit-biased rather than exploratory hypothesis search strategy, relying on rapidly narrowing their hypothesis space to discount lower-probability rules. Data collection is still ongoing, but preliminary results suggest that children (current N = 22) ages 4-6 may display a similar pattern, and may be in the midst of developing adultlike causal reasoning strategies.

4-D-65 When visual attention doesn't explain learning: Spaced learning in children's generalization of STEM concepts

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Children's ability to generalize concepts is a fundamental process in cognitive development. Previous research suggests that variation in the timing of learning influences generalization, such as the finding that massing learning events together in time is less advantageous for learning than distributing learning across time. To date, it is unknown whether visual attention could be a mechanism that contributes to

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spacing effects in children's learning. Thus, the current study examines the link between visual attention and the efficacy of simultaneous, massed, and spaced presentation schedules. In this study, preschool-aged children were shown 16 different science concepts in simultaneous, massed, or spaced schedules. An eye tracker was used to measure participants' looking patterns. Preliminary results reveal that there were differences in visual attention across the three presentation conditions, but these differences could not explain the spacing effect at the delayed test (i.e., a spacing effect). Thus, these findings suggest that visual attention may not be a primary mechanism underlying spacing effects in children's generalization of concepts.

4-D-66 Does the public know what researchers know? Assessing adults' understanding of children's early word learning

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How do children learn language? Major accounts include constraints-principles, sociopragmatic, and domain-general theories, which outline the cognitive and social processes critical to word learning. However, to date, we do not know whether lay adults' understanding of early word learning aligns with seminal research findings in language acquisition. Investigating their understanding is important because adults serve as primary sources of linguistic and extralinguistic input, and children's ability to learn words is highly impacted by the quality of this input (Cartmill et al. 2013). Furthermore, parental attitudes have been shown to affect children's motivation and achievement in related domains like literacy and second language learning (e.g. Abu-Rabia & Yaari, 2012; Bartram, 2006). Thus, the present study examined nonexpert adults' understanding of children's early word learning. We hypothesized that adults would demonstrate lower accuracy on concepts drawing from domain-general theories, such as associative or statistical learning accounts. This prediction is drawn from other studies of adults' understanding of domain-general principles (e.g. spacing effect) of how human memory works (Karpicke, Butler & Roediger, 2009; Kornell & Bjork, 2007, 2008). To test this prediction, 171 adults (age: $M = 20.05$, $SE = 0.90$) completed a survey about 13 word-learning concepts. Questions tested seminal concepts from early word learning research, including the mutual exclusivity assumption, whole object assumption, shape bias, and taxonomic bias. Additional concepts included the role of sociopragmatic cues (i.e. pointing, eye-gaze), and the ability to learn from overheard speech and cross-situationally. Finally, participants were asked whether word learning is facilitated by massed vs. spaced presentation schedules and by varied vs. repeated contexts. For each question, participants were introduced to a preschooler named Gabriel and were prompted to select an answer based on Gabriel's perspective. For example, when testing the mutual exclusivity assumption, participants were shown a familiar and a novel object and told: "Gabriel is a preschooler. Gabriel hears the word "wug". Which one does Gabriel think is the "wug"?". Results supported our hypotheses: Adults demonstrated accurate intuitions about all concepts except those derived from domain-general theories. For example, 98% of participants agreed that pointing was useful in word learning (Fig. 1A). In contrast, a higher proportion of participants did not think children could learn novel words in statistical word learning paradigms (68%; Fig. 1B), in varied contexts (73%; Fig. 1C), and through a spaced presentation schedule (59%; Fig. 1D). These results highlight disconnects in knowledge between the cognitive development research community and the general public, and suggest that more efforts need to be made for communicating scientific findings to the broader nonacademic community. The talk will conclude with a discussion of how to address these gaps in knowledge between researchers and the public.

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4-D-67 Unanswered questions: The role of inquiry in children's memory and categorization of novel objects

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Previous research suggests that questions help children learn through information gained when they are answered (e.g. Mills, Legare, Grant, & Landrum, 2011). However, children only receive answers to their questions 71% of the time (Chouinard, 2007). In this study, we looked at whether children's questions have cognitive consequences in the absence of answers. Participants viewed 12 novel objects and were prompted to ask three questions for each. In another experiment, they were then trained to ask a specific type of question before asking questions for 12 additional objects. We found that children remembered 80% of their unanswered questions, and that children categorized more narrowly when asking feature questions and more broadly when asking category questions. However, children who were trained to ask feature or category questions did not change how they categorized based on these questions. This suggests that children's unanswered questions are indeed related to how they think about the world: they may reflect an underlying bias towards certain types of information that leads them to ask certain types of questions.

4-D-68 Testing a new two-system model of early individuation

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Young infants typically fail to determine the number of objects present in individuation tasks in which the objects differ only in their featural properties. According to a new two-system model of early individuation, infants fail when the object-file (OF) and physical-reasoning (PR) systems both agree that one or more objects are present in a specific location, but disagree on how many are present. This model makes a striking prediction: Young infants should succeed at a standard individuation task in which two featurally distinct objects repeatedly emerged in alternation on either side of the screen as long as the second object remained visible next to the screen at the end of the occlusion event, when the screen was lowered. According to the model, the OF system should assume that the only object present was the one next to the screen, allowing the PR system to specify that another object was also present behind the screen. We tested this prediction in two experiments with 11-month-olds. In Experiment 1, infants correctly individuated two different-patterned boxes as long as one remained next to the screen at the end of the occlusion event. In Experiment 2, infants correctly individuated as many as three different-patterned boxes as long as one remained next to the screen. The results support the two-system model and provide new evidence that individuation failures occur primarily when the OF and PR systems disagree on the number of objects present in a specific location.

4-D-69 Neural oscillations differ in strong and weak word learners

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To better identify the cognitive processes supporting word learning from context in middle childhood, we studied differences in neural oscillations during successful word learning from context in children of varying word learning ability. We focused on changes in theta, alpha, gamma, and beta frequency bands which, in language comprehension tasks, have been identified as indicators of word retrieval, verbal

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working memory, syntactic processing, and prediction of upcoming words, respectively (see Lam et al, 2016). Thirty-seven 10-13 year olds had their EEG recorded while reading 50 sentence triplets, each ending with a novel word to be learned. Using time frequency analysis with a Monte-Carlo cluster correction permutation analysis, we investigated changes in the neural signal from the onset through the first five words of each sentence prior to the novel word. All children revealed significant changes in beta and gamma during word learning, indicating sentence-level unification and prediction. A subset comprised of the top and bottom third performers were identified as strong and weak word learners. The stronger group revealed more alpha engagement than the weaker group, but no group differences were found in theta, beta, or gamma. Further, performance on the task across all participants was positively correlated to increases in alpha ($p < 0.05$), but not beta or gamma. This finding supports prior behavioral work noting correlations between working memory and word learning (Cain et al, 2004). These findings indicate that the cognitive processes that differentiate word learning ability differ from the overall pattern of neural oscillations underlying successful word learning.

4-D-70 Acquiring STEM knowledge through shared book reading

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Variability in children's early STEM knowledge is pervasive and affects school readiness (e.g., Verdine et al. 2017). Shared reading of STEM books is a common practice in homes and may support STEM knowledge prior to formal education. However, previous research has primarily focused on fictional narrations and on how caregivers' reading styles relate to children's language skills (e.g., Haden et al. 1996). Less research has investigated shared book reading of expository books and no known research has examined how textual features of such books influence learning. Children tend to have low working memory capacities and engage less in active processing strategies compared to adults (e.g., Cowan, 1998). Thus, STEM books may enhance early STEM learning if the books have textual features promoting encoding and active processing of STEM information. In the current study, we test how textual features of STEM books may influence early STEM knowledge acquisition during shared book reading. In two sessions, 38 caregivers read STEM books to their 4- to 5-year-old children. Books were chosen based upon our identification of ways in which STEM books might vary in facilitating children's learning. We classified books as being either Low or High in their Support (promoting encoding) and Demand (promoting active processing). Books coded as high in Support were more likely to maintain topics and make causal connections between textual elements. Books coded as high in Demand included questions and interactive prompts. We selected four books that were crossed on their levels (High, Low) of Support and Demand, and caregivers read two of these books per session. After reading, we tested children on their recall of books' facts in an open-ended question format. Half the questions were Global, pertaining to the books' central theme (e.g., "why do animals need shells?") and half were Local, pertaining to specific facts (e.g., "whose shell does a hermit crab live in?"). For analyses, we tested the effects of Book Support (High,Low), Book Demand (High,Low), and Question Type (Global,Local) on recall accuracy. We found main effects of Support ($F = 56.77$, $p < .001$), Demand ($F = 4.71$, $p = .035$), interactions between Support x Demand ($F = 5.32$, $p = .027$) and Support x Question type ($F = 14.96$, $p < .001$). Follow-up tests detected effects of Demand only for the Low Support books. Children performed well on the High Support books regardless of whether the books were either High ($M = .53$) or Low ($M = .54$) in Demand; however, they performed better on the Low Support books when Demand was High ($M = .39$) compared to Low ($M = .25$). On the High Support books, children performed better on the

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Global ($M=.57$) than Local questions ($M=.48$) and on the Low Support books better on the Local ($M=.36$) than Global questions ($M=.29$). The Higher Support books likely facilitated encoding of the central themes as they have greater topic coherence. The results show that books' textual features can promote STEM learning in naturalistic contexts if they include supportive and/or demanding textual features. Future directions include coding individual variations in caregiver's extra-textual talk to test how caregiver communication interacts with the books' textual features to influence STEM learning. In sum, our results highlight that STEM books can enhance early STEM knowledge and emphasizes the importance of reading high quality STEM books to young children.

4-D-71 A large-scale longitudinal investigation of the impact of children's early gestures on later language and communicative development

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Previous studies have found links between children's early gesture use (e.g., pointing to objects) and language development. Our goal was to assess whether early gesture use predicts language development at 5 years of age. To do so, we analyzed data from a large-scale community-based prospective longitudinal study that included language data from mother-child dyads. Analyses of predictive pathways were performed with a total of 1944 children in SPSS Amos, controlling for English language exposure, gender, birthweight, family income and maternal education. There was a direct effect between total gestures at 12 months, as reported on the CDI, and general communicative skills at age 5. However, follow-up mediational analyses showed that vocabulary size at 24 months completely mediated this effect. This suggests that gestures in infancy indirectly impact communication skills during the transition to kindergarten via the effect of gestures on vocabulary size in early toddlerhood.

4-D-72 Segmental specificity of infant statistical learning

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Infants have broad sensitivities to environmental regularities. In the domain of speech perception, infants' sensitivity to co-occurrence patterns in continuous speech has been extensively documented. However, we still know very little about how infants represent sequences that are the output of these statistical learning processes. Previously, we have demonstrated that infants can recognize statistically-defined words across changes in speaker and stress pattern. Here, we test 8-month-olds' segmental representations of newly encountered statistically-defined words. Infants were familiarized with a naturally-produced Italian corpus that contained two high transitional probability (HTP; $TP=1.0$) target words (e.g., fuga & melo) and were tested on their ability to discriminate HTP vs Novel words (Control condition) or modified-HTP (change in place or manner of articulation of initial consonant, e.g., fuga-->shuga & melo-->belo) vs Novel words (Experimental condition). In the Control condition ($n=24$), infants listened longer to HTP than Novel words, $t(23)=3.192$, $p=0.004$, $d=0.648$, replicating previous work. Preliminary data from seven infants in the Experimental condition suggest that infants may not recognize HTP words when a single feature changed between familiarization and test. If our full sample size ($n=24$) shows similar results, it will suggest that 8-month-old infants may have a more robust representation of segmental information than speaker or stress pattern information.

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4-D-73 Examining the relationship between inattention and language in infants in low income households

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Infants in low income households have difficulties with attention (Clearfield & Jedd, 2012) and are at greater risk for language delays. Studies have shown that longer sustained attention is correlated with higher cognitive scores, and that more bouts of sustained attention predict vocabulary over and above joint attention (Yu, Suanda & Smith, 2018). However, the relationship between language and attention has not been tested in a low income sample. We examine whether difficulties with attention during play are related to language in this group. An in-home play session from 24 infants, mean age 19.5 months (13-27) from low income households was coded to measure inattention (time off task) and sustained attention (to toys and parent) (Ruff & Lawson, 1990). Parent report of communication, development, and vocabulary was measured twice about 6 months apart using the Ages and Stages Questionnaire and MacArthur Bates CDI, respectively. Time not attending to the toys was negatively correlated with changes in ASQ communication ($r = -.953$, $p = .001$) and problem-solving scores ($r = -.795$, $p = .033$), but not with vocabulary scores. This inattention appears to have a negative impact on growth of communication skills, but sustained attention was not related to language for this low income sample as reported in high income groups, possibly due to many distractions in the home environment during recording. Poor attention has implications for language success and is a potent target for intervention.

4-D-74 Paving the way to adjective learning via picturebooks: Strategies of children and adults

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The purpose of this research was to explore the strategies 3-year-old children and adults use when learning adjectives in a picturebook reading interaction. The impact of two clues was studied: one provided by the morphology of the word (suffix); another one consisting in verbal information combined with property-highlighting actions regarding the features of the novel adjective (property description). Results show that for children the description was decisive to map the new adjective with the property; for adults, instead, the presence of the suffix was crucial. These results illustrate a developmental shift in the sort of strategies that shapes adjective learning in a picturebook reading context.

4-D-75 Food rejection negatively influences thematic food categorization performance in young children (3-6 years)

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Recent research has identified a negative relationship between the food rejection disposition (food neophobia and fussiness) and taxonomic categorization performance in young children (Rioux, Picard, & Lafraire, 2016; Rioux, Lafraire, & Picard, 2017). The present study aimed to determine whether the reported negative influence of food rejection on taxonomic categorization performance also extends to thematic food categorization performance. To test this hypothesis an analogy task combined with a conflicting triad paradigm was conducted on children between 3-6-years-old ($n = 144$). The intensity of

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food rejection in each child was computed using the Child Food Rejection Scale (CFRS; Rioux, Lafraine, Picard, 2017). Subsequently, the children were first exposed to a pair of pictures instantiating one of the two relations of interest (thematic or taxonomic) and then asked to extend the example type of categorization to choose either the thematic or taxonomic match to a target image. Our results confirmed that both high food neophobia and pickiness scores, alongside incorrect food identification, significantly predicted poorer performance in the thematic categorization of food ($F(2, 135) = 15.46, p < .001, r^2 = .186$). As the first study to detect a negative relationship between thematic food categorization and food rejection, these results suggest that enriching thematic food category knowledge in young children could be an efficient strategy to foster dietary variety.

4-D-76 Disruptions in children's lexical processing following changes in dimensions and the relation to age and executive function

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Children's ability to recover from incorrect interpretations of semantically or syntactically ambiguous sentences improves with age and is associated with individual differences in executive function (EF; Woodard, Pozzan, & Trueswell, 2016; Khanna & Bolland, 2010). Building upon prior research (Pomper & Saffran, 2016), we examined the developmental trajectory of children's ability to comprehend unambiguous sentences when there are unexpected changes in the dimension that is used to identify an object. Children were shown images of two familiar objects and heard a sentence identifying one using either its name or color. Trials were blocked so that the same dimension was used to identify objects for the first 8 trials and a different dimension for the next 8 trials. Both 3- (n=56) and 5-year-olds (n=56) were significantly less accurate in looking to the correct object following the dimensional switch [$t = -3.24, p < .01$] and this decrease in accuracy was the same for both ages [$t = -0.33, p = .75$]. Moreover, 5-year-olds were significantly less accurate in an additional block where the dimension randomly changed between trials [$t = -2.44, p = .01$] and this decrease was associated with individual differences in EF [$t = -2.17, p < .05$]. These results suggest that, across a range of ages, young children are less accurate in comprehending unambiguous, as well as ambiguous, sentences that have unexpected endings, and that their comprehension is associated with domain-general skills like EF.

4-D-77 Take home reading: How repetition in a parent-child read aloud changes over five days

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In prior research on the connection between reading aloud and vocabulary building in preschoolers, transcript analyses show parents appear to spend little effort actively introducing new words. But parents may not always recognize words as new, or may be influenced by book type or research settings. Our study tests the effects of parents' reading aloud on new word retention in 3- to 4-year-olds in a more natural setting with books that intentionally present novel words. Parent-child pairs were provided with either a rhymed or unrhymed version of a story describing 8 imaginary monsters and an audio recorder, and were instructed to record reading the book aloud with their child at home daily for 5 consecutive days. Afterwards children were tested on novel word (monster name) retention with both a picture-pointing identification task and a production task. Recordings of the read-alouds were transcribed and coded for extra-textual elements like number of conversational turns, intentional

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pauses, comments on and repetitions of the novel names. Early findings ($n=12$) indicate that children whose readings involve more conversational elements retain more novel words, and the day-to-day changes in commentary use differ based on whether the book rhymed. Results also indicate reading style varies more across parent-child pairs than within individual pairs over time. In general, children in this study succeeded in learning the monster names after these repeated interactive readings.

4-D-78 Category exceptions stretch category boundaries

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Category learning is a dynamic process. In order to successfully guide future categorization, category representation needs to be both: flexible enough to account for new evidence and stable enough to resist change that does not significantly reduce prediction error. In this study, we tested how items that violate our expectations affect category representations, and whether the effects of deviant items on category representation change through development. Specifically, we wanted to know whether learning a category exception can expend category boundaries or, as previously suggested, learner tends to keep the representation that captures regularity present in the majority of the category members, and supplements it with a memory based representation of the exception. We found that generalization patterns of both young (4-year-old) and adult learners suggest that exceptions can expend category boundaries and thus significantly affect future generalization. We discuss implications these findings have for the extant models of category learning and memory.

4-D-79 When time changes the boundaries: Shifts in children's generalizations after a delay

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In studies of word learning and categorization, children are often taught the name of a novel object and then immediately asked to generalize that label to another object. To better understand how children's generalization of category boundaries changes over time, this study uses a new paradigm. In the present study, participants ($N=38$, $Mage=4.05$ years) saw a novel object labeled by the experimenter (e.g., "This is called a wug!") and then were sequentially shown five novel objects that had an increasing number of features changed from the exemplar (i.e., the fifth object had five changed features). Children saw the five novel objects either immediately after the exemplar or after a five-minute delay, and for each object, the experimenter asked whether it was a member of the same category as the exemplar (e.g., "Is this a wug, or is this not a wug?"). Children endorsed category membership at higher rates at immediate test than at delayed test, suggesting that children's category representations are initially broad but become narrow over time. We propose forgetting as a key mechanism underlying these shifts in children's generalization: as children forget exemplar features, their category representations become narrower.

4-D-80 Neural correlates of fast-mapping

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The current study was designed to establish a link between behavioral and neural responses during a fast-mapping task. Monolingual 30-month-olds observed two types of trials in which two objects

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appeared on the screen, one familiar object (e.g., a cup) and one novel object. In the Familiar trials, a familiar object was labelled (e.g., "find the cup"); in the Disambiguation trials, a novel word was heard (e.g., "find the dofa"). Critically, brain responses were measured using functional Near-Infrared Spectroscopy (fNIRS), which detects changes in hemodynamic response. Preliminary analysis revealed higher activation in right and left frontal areas, areas associated with memory, during Familiar trials. In contrast, higher activation was observed in left temporal regions, areas associated with language processing, during Unfamiliar trials. This increase in temporal activation is likely due to the effort needed to learn new words.

4-D-81 How does active sampling support learning new words?

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Does having active control over their input help children learn new words? We asked whether allowing children (aged 3-5 years) to actively control a portion of their training input during an explicit word learning task supports novel word learning. Participants (n = 226) were first exposed to a set of novel object-label associations that varied in exposure frequency. We then compared children's word learning in an Active condition, in which they could choose which words to learn about next, to two yoked passive conditions, in which participants viewed the same novel labels selected by a (yoked) participant from the Active condition. Children in yoked conditions had either the same (Yoked Passive) or different (Yoked Passive Exposure Mismatch) initial word learning experience compared to each (yoked) Active participant (Fig 1A). Our results support two main conclusions. First, we found that children in the Active condition made informative choices, selecting words they experienced less frequently during initial exposure (M = 60.8%, 95% CI = [57.0%, 64.7%], $t(76) = 5.57$, $p < .001$; Fig 1B). Second, actively selecting words that complement past learning experience matters. Children in the Yoked Passive Exposure Mismatch condition (M = 77.1%, 95% CI = [72.1%, 82.0%]) - unlike children in the Yoked Passive Condition, M = 82.1%, 95% CI = [77.7%, 86.4%]) - showed worse learning than children in the Active condition (M = 84.9%, 95% CI = [80.9%, 88.9%], $z = 2.52$, $p = .01$; Fig 1C). Our results illustrate when and why active learning can benefit young word learners.

E – Psychological and moral reasoning

4-E-82 Children's evaluation of peer punishers

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Previous research has documented that by five years of age children value those who enforce norms (Vaish et al., 2016). It is unclear whether this preference for norm-enforcement extends to those who engage in direct punishment, such as taking away resources or social ostracism. On one hand, children - like adults (Jordan et al., 2016) - may prefer punishers because they consider them trustworthy and cooperative. Alternatively, they may disapprove of peer punishers because children tend to categorically disavow harmful actions (Jambon & Killen, 2013). Here, we examined whether 5- to 8-year-old children (n = 82) and adults (n = 80) prefer punishers above and beyond individuals who merely enforce norms verbally. We told participants stories featuring a transgressor and potential intervener. We varied whether the potential intervener did nothing, enforced the norm, or punished, and measured social

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evaluations on several dimensions. Adults preferred both types of intervention over non-intervention, but preferred norm enforcement over peer punishment. Eight-year-old children similarly preferred norm enforcement over non-intervention, whereas younger children showed no systematic preference. These findings suggest children's approval of norm enforcement emerges late in development, with approval of peer punishment emerging even later, raising questions about the reputational benefits of direct intervention.

4-E-83 Perceptions of societal inequalities relate to children's conceptions of wealth acquisition and social mobility

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Perceptions of fairness in society, including whether societies have unequal or egalitarian distributions of wealth, develop over the course of childhood and adolescence. It is not yet known whether perceptions of societal wealth distribution are directly related to children's views of wealth acquisition (if wealth stems from individual or structural sources) or conceptions of social mobility. In this study, 191 American 9-14 year-olds selected their perceived societal wealth distribution of the U.S. from pictures depicting unequal (most citizens represented at the bottom of the hierarchy) or egalitarian (most citizens at the middle or top of the hierarchy) distributions, along with assessments of wealth status. Results revealed that children who viewed the U.S. as largely egalitarian (as opposed to unequal) were more likely to assume that high wealth status was caused by individual reasons, such as hard work or intelligence, whereas children who viewed the United States as unequally distributed were more likely to assume that high wealth status was caused by structural reasons, such as unequal advantages or inheritance ($p=.03$). Moreover, those who selected more egalitarian distributions were less likely to believe that high wealth children would grow up rich and low wealth children would grow up poor than those who selected more unequal distributions ($ps<.01$), indicating that social mobility is viewed as less likely by those who perceive an unequal U.S. societal distribution. Thus, children's views about wealth inequality suggest that those who view societies as unequal are more likely to recognize structural constraints and view mobility as unlikely.

4-E-84 Do children evaluate others' humanity based on their moral character?

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Adults dehumanize (i.e. view some as less human than themselves or others) and this tendency has unfortunate social and moral consequences. We developed a novel measure of dehumanization for children which involves rating targets' physiological capacities (e.g., ability to experience pain), emotional capacities (e.g., ability to feel love), and cognitive capacities (e.g., ability to solve problems). We examined whether children dehumanize based upon a person's moral character (i.e., whether they are prosocial or antisocial), which adults have previously been shown to do (e.g., Khamitov, Rotman, & Piazza, 2016). 4- to 9-year-old children ($N=96$) evaluated the humanity of two targets, one acting immorally and one acting neutrally. Overall, children rated the immoral target as less human than the neutral target, and this effect grew stronger with age. This result is primarily driven by participant's low ratings of the immoral target with respect to positively-valenced capacities, such as feeling love and experiencing pleasure. Children view immoral others as less capable of experiencing the good, but unlike adults they otherwise view immoral targets as fully human.

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4-E-85 Ingroup bias exists regarding accusations of cheating in a competitive intergroup context

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Little is known about the role of ingroup bias on children's accusations of cheating in a competitive context. In competitive situations when ambiguity surrounds the potential intention to cheat, group affiliation may lead children to support claims of cheating based on team affiliation of the claimant. The present study examined how participants ($N = 142$), ages 4 to 10 years old, evaluated the legitimacy of a claimant who was either in the ingroup or outgroup. Participants were assigned to either a red or blue team to participate in a team contest. Participants heard a vignette which revealed an ambiguous situation where a blue team member may have cheated to help their team win and a red team member claimed the blue team cheated. Children initially assigned punishment to the potential rule violator before hearing the claim (no punishment = 1, a lot of punishment = 6), and then evaluated the claim (1 = really not OK, 6 = really OK) and motivation behind the claim (0 = truly believed the blue team cheated, 1 = just wants the red team to win). Children on the red team thought the potential rule violator should be punished more than did children on the blue team, $F(1, 136) = 5.744$, $p = .018$. Additionally, the red team evaluated the claim of cheating as more acceptable than did the blue team, $F(1, 136) = 7.944$, $p = .006$. Further, children on the red team were more likely to say the claimant truly believed the blue team cheated while children on the blue team said the claimant just wanted the red team to win, $F(1, 136) = 6.626$, $p = .011$. In an ambiguous, competitive intergroup context, children's own team membership impacted their assessment of claims of cheating.

4-E-86 Children's inferences about digital tracking as a result of ingroup and outgroup differentiation

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Over the past few decades, a "digital revolution" has created widespread access to technology in society. While recent studies have shown that adults may express concern over the digital privacy implications of current technology use, there has been little research on children's understanding of this same issue. In the present study, 92 children (five- to 16-year-olds) and 40 adults (18- to 22-year-olds) were asked whether it was acceptable for one member of a novel group ("Hibbles" or "Glerks") to use a mobile GPS device to track an object belonging to another member of the same (ingroup) or opposite (outgroup) group. Participants' average response to outgroup tracking was more negative ($M = -1.95$, $SE = 0.24$) than their response to ingroup tracking ($M = -0.11$, $SE = 0.27$), and they viewed the tracking of themselves to be more negative ($M = -1.87$, $SE = 0.25$) than the tracking of others ($M = -0.88$, $SE = 0.24$). Additionally, participants were less accepting of mobile GPS tracking with age. An understanding of the varying levels of moral judgment towards digital tracking at different ages has profound implications for comprehending the development of digital privacy conceptualization in children, and can shape decisions made regarding children's digital security in the future. Keywords: digital tracking, children, privacy, ingroup, outgroup

4-E-87 The influence of sharing experiences on costly third-party punishment in children

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Humans are willing to punish individuals who violated fairness norms at a personal cost, even if they are not directly affected. This so-called costly third-party punishment is a well-established phenomenon in adults (Fehr & Fischbacher, 2004). Recent work shows that third-party punishment emerges around 5-6 years of age (McAuliffe et al., 2015). In the present study, we tested whether children's sharing experience affects their subsequent punishment. One hypothesis is that being treated unfairly elicits a sense of justice, resulting in increased third-party punishment. Alternatively, the experience of receiving fewer resources could children feel disadvantaged and impoverished, leading to decreased third-party punishment. In Study 1, we tested N=120 5- to 9-year-olds. Children first experienced either fair or unfair sharing as a second-party recipient. Subsequently, children observed how another person shared resources either fairly or unfairly with a third party. Children could either accept or punish the divider's offer. We found that those who experienced unfair sharing punished less often than those who experienced fair sharing ($b=-0.60, p<.05$). In Study 2 (planned N=160; 75% complete), we aim to replicate the findings from Study 1 and disentangle children's perception about how others treat them from their perception about their own coin endowment (i.e., feeling impoverished). We discuss how studies with children can elucidate the foundations of punishment in humans.

4-E-88 **Origins of the concepts cause, cost, and goal in prereaching infants**

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We view ourselves and others as causal agents who pursue goals, have limited energy, and make things happen, but where do these intuitions come from? We investigated the origins and interrelations of causal knowledge and knowledge of agency in 3-month-old infants, who do not yet reach for or act on objects. Across 5 experiments, N=152 prereaching infants viewed object-directed reaches that varied in efficiency (following the shortest physically possible path vs. a longer path), goal (moving an object vs. causing a change in its state), and causal structure (action on contact vs. action at a distance and after a delay). In Experiments 1 and 2 (N=40 in total), we tested whether prereaching infants responses to reaching and grasping actions. Infants viewed video clips of an actor who reached over a barrier, grasped and lifted a ball, and moved the ball to her side of the barrier. The height of this barrier varied across trials, and the person always adapted her reach to the barrier. After infants habituated to these events, we measured their attention to alternating test events in which the person reached for the same ball as during habituation, but with no obstacles in her way. On alternating test trials, she reached on the same curvilinear path towards the ball (a familiar but newly inefficient action) or on a direct path (a novel but newly efficient action). Infants showed no strong looking preferences under these conditions, especially when the person reached while wearing a glove (Experiment 1 (glove): $M_{ineff}=18.03s$, $M_{eff}=16.84s$, standardized beta coefficient (β)=0.185, $p=0.359$, two-tailed; Experiment 2 (bare hand): $M_{ineff}=9.72s$, $M_{eff}=8.04s$, $\beta=0.429$, $p=0.043$, two-tailed), replicating previous work (Skerry, Carey, & Spelke, 2013). In Experiment 3 (N=40), we tested infants' responses to almost identical videos except that the actor contacted the object with her hand, causing it to light up. In contrast to Experiments 1-2, infants robustly looked longer at the inefficient reach under these conditions, ($M_{ineff}=15.448s$, $M_{eff}=12.368s$, $\beta=0.501$, $p<.001$, two-tailed). A control condition in Experiment 3 ruled out the interpretation that infants responded to lower-level features of these actions by testing their responses to person performing the same reaches with the barrier behind the goal object, out of the actor's way: Infants showed the opposite looking preferences in this control condition ($M_{ineff}=8.79s$, $M_{eff}=10.10s$, $\beta=-0.280$, $p=0.032$, two-tailed), and they responded differently across the experimental and control

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conditions ($\beta=0.781$, $p<.001$, two-tailed). Experiment 4 ($N=20$) revealed that infants show a key signature of adults' and older infants' causal inferences (Michotte, 1963; Muentener & Carey, 2003, Leslie, 1984): Their longer looking to the inefficient action was abolished if a short spatial and temporal gap separated the actor's hand from the state change of the object (Mineff=15.31s, Meff=16.38s, $\beta=-0.096$, $p=0.649$, two-tailed). Experiment 5 ($N=52$) directly replicated this key finding: Infants appreciate the constraints on goal-directed reaching only if these actions give strong impressions of causal agency, involving contact with an object that immediately changes state. Thus, infants may enter the first months of life with little knowledge of the actions or the goals of the people around them, but they may rapidly learn this information by knowing that there are actions, causes, and goals to search for in the first place.

4-E-89 The development of racial bias: Parental and media influences

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Racial bias is pervasive throughout the U.S. and leads to numerous negative consequences for marginalized groups. Although bias stems from many factors, research has identified essentialist beliefs about social categories and social norms as contributors to the formation of racial bias. Using novel assessments, we examine how parental essentialism about status disparities and two sources of social norms (parental value of diversity and diversity of children's media) relate to children's racial bias. Methods Children (4-8 years; $N = 119$; 17 Asian, 15 Black, 19 non-Black Hispanic, 20 Multi-racial, 3 Other, and 45 White) rated how much they liked a series of Black and White children. Parents simultaneously completed a survey assessing their essentialist beliefs about status disparities and two sources of social norms: Child's favorite media (TV shows and/or movies) and how much they value the racial diversity of their child's friend group. Results Parents who endorsed essentialist explanations for status disparities had children who demonstrated higher levels of pro-White racial bias ($p = .006$). Interestingly, parental value of diversity was associated with an increasing level of pro-White racial bias for White participants with age ($p = .04$). Finally, children whose favorite media represented primarily racial minority characters held lower levels of pro-White bias compared to those who favored media with primarily White ($p = .014$) and non-Human characters ($p = .030$).

4-E-90 Disadvantageous inequity aversion in 24-month-olds

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The resistance or aversion to inequality is thought to be a foundational basis for human social decision-making and behavior. Despite its ubiquity, the origin and development of this sensitivity is poorly understood in children younger than 3 years. We designed and preregistered (<https://osf.io/s9rvn>) a modified economic game, comparable to Blake and McAuliffe (2011), in which 24-month-olds ($n = 13$, females = 5) had the chance to accept or reject advantageous (3-0, 3-1), equal (1-1, 3-3), and disadvantageous (0-3, 1-3) distributions between themselves and a third-party present in the same room. Preliminary results suggest that despite accepting all distributions at the same high rate, participants took longer to accept distributions where they had nothing to gain (0-3) compared to all other distributions (3-0, 3-1, 3-3, 1-1, and even 1-3). These results suggest that inequity aversion influences decision-making behavior by discriminating between zero and multiple types of nonzero distributions by the beginning of the second year of life.

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4-E-91 Target's racial group membership modulates 3-5-year-olds' ability to theorize about others' mental states

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The ability to take another person's perspective when they are in conflict with one's own starts around the age of 3 and is generally acquired by the age of 5. The goal of this study is to explore whether this ability is modulated by the target's racial group membership during perspective-taking development in preschoolers. Using a between-groups design with random assignment (N=86; 28 3-4-year-olds [Pre-K 3]; 26 4-5-year-olds [Pre-K 4]; 32 5-6-year-olds [Pre-K 5]) we tested children's ability to attribute mental states to racial in-group and out-group members through a target-modified version of a five-item preschooler Theory of Mind scale. As expected, Pre-K 5 children performed at ceiling, leaving no room for a target's effect. However, children within the developmental period (i.e. Pre-K 3 and Pre-K 4) exhibited an advantage in theorizing about the mental states of the racial out-group targets. This effect was not correlated with children's in-group biases (explicit and implicit) or verbal intelligence. The present results suggest that activating an out-group mind-set enhances the cognitive capability of theorizing about others' thoughts. This finding adds a new perspective in the understanding of the development of social biases towards out-group members during the preschool years.

4-E-92 Developing fairness: The role of number cognition in developing our understanding of exact equality

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Previous research has shown that children develop normative expectations of fairness (understanding fairness as a social norm) at a young age (Lucca, Pospisil, & Sommerville, 2018), though little is known about how or why these normative expectations change over developmental time. In this study, we investigated whether young children might shift from approximate representations of fairness (good sharing = sharing something) to exact representations (good sharing = sharing equally). In addition, we investigated how this shift might be explained by two aspects of young children's number cognition: their approximate number system (ANS) acuity, and their counting skills. Sixty children, aged 3-6 years old, were tested on a third-party, non-costly fairness task, in which they completed 6 trials. In each trial, they were presented with a character with 10 candies who shared either 2, 4, 5, 6, 8, or 10 of these with a friend. They were then asked whether each split type was permissible. Children were also tested on an ANS acuity task and the Give-N task to assess their approximate number sense acuity and their counting skills, respectively. Age predicted the shift from approximate fairness to exact fairness: older children were more likely to endorse only exactly equal (5-5) splits. This was explained by both ANS acuity and counting proficiency. These results demonstrate how children's number cognition is a key cognitive driver of their developing representations of fairness.

4-E-93 The relations between subtypes of moral behavior and evaluation in preschool

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Past research shows that young children perform various types of moral behaviors and evaluate others' moral actions. It remains unclear whether distinct aspects of moral functioning comprise a unified

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construct and share similar cognitive and emotional mechanisms. The present study examined the relations between different subtypes of moral functioning, as well as their cognitive and emotional correlates, in preschoolers. Participants were 171 typically developing 3- to 6-year-old children. Each child participated in several tasks: Moral tasks assessed their performance of various moral actions and evaluations of moral scenarios presented both verbally and non-verbally. Non-moral tasks assessed general cognitive skill, executive functioning, theory-of-mind, and emotion recognition. Temperament (e.g., shyness) was coded from video acquired during participation. Results showed positive associations amongst distinct moral actions, as well as amongst distinct moral evaluation tasks, but few associations between tasks assessing moral actions and moral evaluation. Temperament and inhibitory control each emerged as important predictors of preschoolers' moral functioning. Together, our findings shed light on the nuanced relations between different aspects of moral functioning in preschool, and highlight the importance of temperament and inhibitory control in the development of moral behaviors and cognition.

4-E-94 Effects of 'We-framing' on preschoolers' helping, sharing, and commitment

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Previous research suggests a 'normative turn' in development. This emerges around three years of age within the context of collaborative activities. Thus far, no research has investigated how task framing interacts with children's emerging moral psychology. This is interesting, as framing has diverse effects on adult behavior. To remedy this, this study investigated the effects of collaborative 'we-framing' and individualistic 'you-framing' on preschoolers' sharing, helping, and sense of obligation towards an experimenter-controlled puppet. Child-puppet dyads completed a coloring game that was introduced and maintained using either collaborative or individualistic language. Preliminary results mostly align with hypotheses, with older children (3;6 to 4;6) distributing resources more equally than younger children (2;6 to 3;6) following collaborative framing. Additionally, measures of instrumental helping suggest no effect of framing for either age group. Measures of sense of obligation display a mixed pattern. These results suggest an unexplored type of context sensitivity in children's developing morality.

4-E-95 The emergence of speciesism across development

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Adults care more about other people than they do about nonhuman animals. Many of us eat cows and pigs, for instance, while few would approve of raising humans as food. But no research has yet explored the emergence of this bias across development. In this project we tested children aged 5-9 years (N = 162) and adults (N = 220) using a forced choice rescue dilemma, where subjects had to choose between, for example, saving one person versus ten dogs or ten pigs. Preliminary results suggest that, as expected, adults are highly speciesist, prioritizing humans over large numbers of animals. Surprisingly, though, children are more egalitarian, often choosing to save the animals. Moreover, we find higher rates of speciesism in older children than younger. Data from control conditions (e.g., choosing between saving one person versus ten plates) suggest that children are understanding the task, and not merely choosing the largest number. Our findings suggest that speciesism is not a natural default, but rather emerges over the course of development.

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4-E-96 Friend or rule? The competition of "in-group favoritism" and "norm-focused concern" in costly third-party punishment game

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How do "in-group favoritism" and "norm-focused concern" function in preschoolers? Here, we gave 4-6 years-olds (n = 109) an opportunity to participate in a costly third-party punishment game. Minimal group paradigm was used to assign team. Then an experimenter demonstrated that a distributor allocated 4 stickers to a receiver either fairly or selfishly. The participant was the third-party observer and had to decide whether to accept (no cost to anyone) or to punish the distributor (pay cost to reduce distributor's payoff without affecting the receiver's payoff; using 1 sticker deducted 1 sticker from the distributor). Importantly, the distributor and the receiver were either in or out of the participant's group. We adopted a 2 (distributor, ingroup vs. outgroup) X 2 (receiver, ingroup vs. outgroup) X 2 (allocation, fair vs. selfish) within-subject research design; therefore, each participant engaged in 8 trials in total. The results showed a significant main effect of distributor, such that an outgroup distributor was punished more harshly than an ingroup distributor. In addition, there was an interaction between receiver and allocation. Specifically, when the allocation was fair, 4-6 years-old children punished more on distributors who were fair to out-group receivers than who were fair to in-group receivers. However, when the allocation was unfair, children punished equally, showing no bias between in-group and out-group receiver. It suggested that when fairness norm was not violated, children showed "out-group hate", tending not to see an outgroup receiving fair allocations; by contrast, when fairness norm was violated, children prioritize norm over group relationship.

4-E-97 Introducing ToMcat, a videotaped, open-access violation-of-expectation task for measuring false-belief understanding in infants and toddlers

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Theory of mind (ToM) - the ability to infer others' mental states - is essential for human social interaction. Investigators have long been interested in determining when this ability first develops. Much of this research has focused on false-belief understanding (FBU), which is widely perceived to be an important facet of representational ToM. Initial studies using explicit tasks suggested that children are not capable of FBU until about 4 years of age. Subsequent investigations using implicit tasks suggested that some capacity for FBU is already present in infancy. However, recent non- or partial-replications of implicit FBU findings have led a number of researchers to question the reliability and validity of implicit measures of FBU. For violation-of-expectation (VOE) tasks reporting positive evidence of infant FBU, in particular, one challenge has been that these tasks have typically used live scenarios, making it difficult for other labs to recreate them precisely. Our goal in the ToMcat project is to create a videotaped VOE task that yields reliable evidence of implicit FBU in infants and toddlers and can be easily used by other researchers interested in early ToM. To this end, we have designed a non-verbal change-of-location task depicting interactions between two animal puppets, a cat and a dog. In the first two familiarization trials, while the cat watches, the dog places a toy in one of two open containers (side is counterbalanced); the dog then leaves the scene, and the cat reaches for the toy and pauses until the infant looks away and the trial ends. In the next two familiarization trials, the cat leaves briefly after seeing the dog place the toy in one of the containers, and then it returns to get the toy. Finally, the two

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test trials are identical to the last two familiarization trials, with two exceptions: The containers now have lids, and the dog moves the toy to the other container while the cat is away. Of interest is whether infants will look longer when the cat returns and reaches for the container that currently holds the toy (unexpected event) as opposed to the container that it falsely believes still holds the toy (expected event). In an initial study, we tested 24 18- to 28-month-olds using a within-subject design. Looking time to the final frame of each test event was measured using an EyeLink 1000 Plus eye-tracker in a remote-arm configuration. Children looked reliably longer at the unexpected than at the expected event ($p = .006$), with 19/24 showing this pattern ($p = .003$). Positive results were also found when considering only the first test trial children received ($p = .009$). Children thus attributed to the cat a false belief about the toy's location and found it unexpected when the cat failed to act in accordance with its belief. The second step in the ToMcat project (which is already under way) is to verify these results ourselves in a pre-registered replication of our false-belief condition, along with a compatible true-belief condition. The third step will be to invite other researchers to participate in a preregistered, multi-lab replication using the same stimuli (on either an eye-tracker or a TV). We hope these efforts will be useful to the field in two ways: by contributing evidence to the ongoing debate on implicit tests of FBU using open and transparent best practices in the field, and by providing researchers with an easy and reliable resource for assessing early FBU in their own labs.

F – Social cognition and social learning

4-F-98 Similarities in gender development among transgender and cisgender children

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Gender is a central category that, starting at an early age, shapes children's reasoning about themselves and others. Though clear patterns of gender development have been documented among cisgender children, transgender children's (i.e., children who are living as a gender different from their sex assigned at birth) gender development is little understood. In this largest study of gender development in an emerging cohort of transgender children ($N=317$), we used established measures of gender development and found two main findings. First, transgender children's gender development aligned with the gender they currently identify as (on all measures, $ps < .001$). For example, a transgender boy in our sample was more likely to identify as a boy and show preferences that are stereotypical of boys. Second, transgender children's gender development did not differ from two comparison groups: cisgender siblings ($N=189$) and cisgender controls matched for gender and age ($N=316$) (see Figure 1). That is, transgender children's identity and stereotyped preferences closely resembled those of cisgender children of the same gender (and not of the same assigned sex). Thus, our findings suggest that, socially transitioned transgender children's gender development looks similar to the development of children who have been born and raised as their current gender since birth.

4-F-99 Electrophysiological mechanisms of joint action and feedback in adolescents

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The aim of the present research was to identify the effects of joint action and feedback in motor coordination and brain activity in adolescents. 34 adolescents and 40 adults were grouped in dyads and they performed a visual detection task during EEG recording. They were instructed to press a button in

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response to visual stimuli in 4 conditions: individual non-feedback (IN), individual with personal and interpersonal feedback (IF), joint non-feedback (JN), joint with personal and interpersonal feedback (JF). In individual conditions, participants should press the button as quickly as their previous answer. In joint condition, participants must press the button as quickly as their partner. Feedback indicated response time in a color code. Event related spectral perturbation was computed in response interval. Results showed that adults, but not adolescents, use information about the other person to improve behavioral performance in joint conditions. Furthermore, adults had higher beta power in the right hemisphere at 300 ms in JN condition than adolescents; similarly, adults had higher alpha/theta power at 300 ms in JF condition than adolescents. Regarding to condition comparisons, adolescents had higher beta right frontal activation in the joint than in the individual condition and; adults had higher theta posterior activation in the joint than in the individual condition. Overall, results suggest a differential neural activation to process social feedback cues between adolescents and adults. These maturational changes from frontal beta to posterior alpha/theta oscillations in adults, allow them to improve the comprehension and response to their partner actions.

4-F-100 Sensitivity of young monolingual and bilingual children to language and accent when allocating resources

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Children are sensitive to the languages spoken by social partners, with monolingual children showing social preferences (e.g., increased trust) for speakers of their native language. Although many studies have examined children's stated preferences, fewer have examined children's treatment of social partners, particularly by and towards bilingual speakers. This study examines how language and accent influence resource allocation in 4-7-year-old English monolingual and Spanish-English bilingual children ($n = 39$; 24 monolingual; data collection on-going). Children divided 5 tokens between pairs of speakers: (1) native-accented English vs. Spanish, (2) native-accented English vs. Spanish-accented English, (3) Bilingual (native-accented code switching) vs. native-accented English, and (4) Bilingual vs. Spanish. There was a significant main effect of child's language on resource allocation ($F(1,37)=7.66$, $p<.01$). Monolingual children gave significantly more to native English speakers compared to Spanish and Spanish-accented English speakers, with a smaller bias for native English versus bilingualism (Figure 1). Bilingual children, in contrast, displayed no biases for any comparison. Monolingual speakers also showed greater native English bias in resource allocation than in friendship preferences. These results suggest that monolingual children show behavioral biases in favor of their linguistic in-group, but bilingual children may not privilege bilingualism in the same way.

4-F-101 Expectations about teaching styles shape inferences and exploration

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Learners often rely on others for information, and teachers can vary in how they present that information. Children may assume that teachers in pedagogical contexts are fully informative, which can constrain future exploration (Bonawitz, Shafto et al., 2011). Yet benefits have also been found for learning from under-informative teachers, suggesting that learning is superior in Guided Play (GP), compared to Direct Instruction (DI) and Free Play (FP; Fisher et al., 2013). How do learners leverage information about different teachers to draw inferences from new pedagogical demonstrations? We

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suggest that expectations about teaching style may shape learning through inferences over (1) the amount of information to be learned, and (2) the importance of demonstrations. This interpretation provides a plausible factor that improves learning from GP: It strikes a balance between DI (which curbs exploration through inferences about the amount of information) and FP (which does so via the implied importance of demonstrations). In Exp1, we test these predictions in adults. In Exp2, we ask whether these inferences pan out in children's exploratory play. Exp1: 300 adults were recruited from mTurk, with 50 in each of three conditions for each experiment (1a & 1b). Participants saw three videos of adults teaching children about a simple toy. Each teacher used a different teaching style (DI, GP, FP). Teaching style was counterbalanced across the videos; the final teacher viewed was the Test Teacher. Participants were then told to imagine that the Test Teacher showed them one thing on a new toy. In 1a, participants were asked how many functions they thought were on this new toy. In 1b, participants instead rated the importance of the imagined demonstration. 1a: As predicted, participants in the FP condition inferred significantly more functions than those in the GP condition, who inferred more functions than those in the DI condition ($p < .001$). 1b: We found marginally significant group differences ($p = .059$), significant post-hoc comparisons between FP and DI ($p = .048$), and a linear trend ($p = .019$). Thus, FP and DI may be on opposite ends of a spectrum, such that learners believe demonstrations are more important the less they expect a teacher to show. We also successfully modeled our results, suggesting that adults are approximating rational solutions to this complex social inference problem. Exp2: Data collection is still ongoing; 44 preschoolers (M(age)=57 mos; N=14-15/condition) have been tested so far (30/condition preregistered). Children first saw the same three videos as in Exp1. Then the Test Teacher entered the room, and provided one pedagogical demonstration on a novel toy. Children explored the toy for up to 7 minutes. The length and variability of children's play, as well as their focus on the demonstrated function, were coded from videos. While we are currently underpowered and statistical tests are not yet significant, patterns in children's play are consistent with the idea that children are making similar inferences as adults did in Exp1. Children in the GP condition played for longer, and performed more unique actions on the toy, than those in the FP and DI conditions. Proportion of playtime with the demonstrated function was also lowest for GP and highest for DI. (Fig.s in supplement) This work demonstrates how learners may bring expectations to bear in new learning scenarios, and identifies the inferences by which this process may operate.

4-F-102 Social referencing as epistemic information-seeking in preverbal infants

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Social referencing has been proposed to serve an epistemic (as distinct from emotional) information-seeking function (Begus & Southgate, 2018; Harris & Lane, 2014), but little is known about its use in pre-verbal and pre-pointing infants. 11-month-olds (N = 48) were presented with familiar objects, with caregivers enabling three between-subject conditions: Congruent (caregiver providing a matching label to the object), Incongruent (mismatching label), and No label (caregiver not providing any label but instead saying: "Look at this!"). Upon the caregiver's utterance, objects remained on the screen and infants' instances of social referencing were coded. Infants engaged in more social referencing in Incongruent compared to both No label and Congruent condition. These results extend the role of social referencing beyond the classical emotionally driven account (e.g., Sorce et al., 1985) as a communicative information-seeking cue developing prior to interrogative pointing (e.g., Begus & Southgate, 2012).

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4-F-103 Young children consider others' physical constraints to infer their unobserved actions

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To predict and respond to others' actions, one must understand what others can and cannot do. We investigate whether children consider others' physical constraints to infer what they could have done and plan their own actions. Three-year-olds (N=32; pre-registered; within-subjects) learned that while they could easily reach inside two boxes---one with a big opening on the front, the other with a small opening---the experimenter could only reach into the big-hole box (her hand was too big for the small-hole box). Two identical toys were lost, one in each box, and the experimenter withdrew one toy without children seeing from which box and asked for help retrieving the other toy. Children searched in the small-hole box (69%; $p=0.03$), suggesting that they used the experimenter's physical constraints to infer that she retrieved the toy from the big-hole box. Children did not simply prefer the small-hole box; when given a clear reason to approach the big-hole box (the experimenter could reach inside both boxes, different toys were lost, and the experimenter withdrew the toy in the small-hole box), children readily searched in this box (94%; $p<0.001$). In an ongoing pre-registered replication (planned N=64), we manipulate only the experimenter's physical constraints (she either cannot reach in the big-hole box, or cannot reach in the small-hole box); pilot data suggests children flexibly respond to these constraints, inferring her unobserved action to plan their own. The ability to reason about what others can and cannot do emerges early and is foundational to successful joint-action, whether it be to help, cooperate with, or out-compete others.

4-F-104 Do toddlers have pro-wealth attitudes? Early biases and how to reduce them

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In many countries around the world, there is a large gap between the rich and the poor. This pervasive tolerance for social and economic inequality is particularly puzzling in light of the evidence that an equity-based sense of fairness emerges early in life. In resource-allocation tasks, for example, young children take individuals' prior resources into account: Although they divide resources equally among similarly advantaged individuals, they allocate more resources to disadvantaged than advantaged individuals. But if fairness is a universal component of human moral cognition, why are we content to live in unfair societies? To address this issue, researchers across the social sciences have explored numerous factors ranging from self-interest to system justification. Within developmental psychology, one factor that has recently received a great deal of attention is a preferential bias toward the resource-rich: Children age four years and older have been shown to prefer advantaged over disadvantaged individuals. Here we asked two questions: Would 2-year-old toddlers already exhibit this affiliative preference for the resource-rich, and if yes, were there interventions that might reduce it? In Experiment 1, toddlers first received three familiarization trials in which an experimenter (E) revealed the belongings of two dolls to demonstrate that one was resource-rich and the other was resource-poor. Next, in each of four test trials, the dolls expressed different preferences or opinions and then left; children then endorsed one of the dolls. Thus, (1) one doll preferred toy-A, one doll preferred toy-B, and children were asked which toy they preferred; (2) the dolls used different sides of a bell apparatus to ring a bell, and children then rang the bell using one of the sides; (3) when asked which of two toys was a "wug", one doll pointed to toy-C, one doll pointed to toy-D, and children were asked to give E the wug;

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and (4) when asked which of two toys rattled when shaken, one doll pointed to toy-E, one doll pointed to toy-F, and children had to find the rattle. Across trials, toddlers significantly endorsed the preferences and opinions of the resource-rich doll. Experiment 2 examined whether toddlers' preference for the resource-rich doll might be reduced by providing personal details about each doll outside of their resource-status. The procedure was similar to that of Experiment 1 with one exception: Before the familiarization trials, toddlers were shown story books that reported three items about the dolls (e.g., one doll had a sister, liked coloring books, and enjoyed playing on the swing at the park). Toddlers heard stories about either both the dolls or one of the dolls (resource-rich or resource-poor). After E read the stories, the same familiarization and test trials in Experiment 1 took place. Toddlers that saw the two books and only the resource-poor book now endorsed either doll at chance-level. Together, our results indicate that by 2 years of age, children already prefer and endorse a resource-rich over a resource-poor character. However, providing additional personal information about the resource-poor, thus humanizing them, helps reduce this pro-wealth bias.

4-F-105 When innovators succeed: Empowerment strategies increase preschoolers' exploration

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Research shows that children's active learning can maximize information-gain (Bonawitz et al., 2012; Ruggeri et al, 2016). But, few (if any) studies have investigated whether competing experiences of empowerment and helplessness (Abramson, Seligman, & Teasdale, 1978) may affect exploration. In study 1, 72 preschoolers (M=55.5mos; Range=47.5-67.4mos) were randomly assigned to the Learned Empowerment (LE, "We can do something!"), Learned Helplessness (LH, "Well, there's nothing we can do"), or Baseline (no prompt) condition, and complete two trials in which they receive worse toys than a confederate's. Children then play with a novel toy after an initial demonstration. The LE condition performed marginally more unique actions with the toy (one-way ANOVA, $F(2,69)=2.48$, $p=0.091$), with a significant difference between the LE condition and the LH condition ($t(46)=2.17$, $p=0.035$). Study 2 replicated methods with 72 preschoolers (M=57.0mos; Range=48.3-69.7mos) but elongated playtime and included an exclusion criteria for participants who refused to ask for help when prompted (10). There was a significant effect across conditions for unique actions performed (one-way ANOVA, $F(2,69)=3.61$, $p=0.032$), and between the LE condition and LH condition ($t(46)=2.25$, $p=0.028$). These results show that children are sensitive to their own exploratory potential, which can be mediated by feelings of empowerment or helplessness.

4-F-106 Drawing conclusions about intergroup bias: Children's drawings of outgroup members

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Biases favoring one's in-group over out-groups emerge during the preschool years (Nesdale, 2004), and can be heightened if children hear negative messages about out-groups (e.g., Lane, Conder & Rottman, 2019). In the current study we evaluated 4- to 9-year-olds' (N=119) impressions of novel groups after children overheard a video call in which the caller either did or did not make negative claims about the group. Children were later asked to draw themselves and a member of the novel group on a piece of paper, as an implicit measure of intergroup bias. Drawings can capture biases that children may be hesitant or unable to verbalize, providing researchers with rich information about children's social

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concepts (Gonzalez-Rivera & Bauermeister, 2007). Multiple aspects of children's drawings were evaluated, including relative size of drawings (group member - self), use of favorite and least favorite colors for the group member, facial expressions (smile, frown), and negative embellishments to the group member (blood, fangs). Children who overheard negative claims about the group drew a group member as taller (relative to themselves) than children who did not ($F(1,114)=4.92$, $p=.029$). Children who overheard the claims also used more of their least favorite colors to draw the group member ($F(1,111)=5.64$, $p=.019$). Additional findings, including data from children's self-talk while drawing, longitudinal data, and developmental trends will be presented.

4-F-107 Children's judgments of environmental free-riders

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Free-riders are individuals who benefit from group acts without a personal contribution. Both adults and children negatively evaluate and sanction free-riders. The current research investigates children's judgments of free-riders in the context of the environment which is arguably the largest common good targeted by free-riding. Children's perceptions of free-riders in the context of environmental harm are valuable in understanding early judgments and concerns for the environment. In this study, 85 four- and five-year-old children were read four stories featuring free-riders: two environmental (i.e. picking up trash) and two non-environmental (i.e. cleaning up toys). In the stories, a character was a free-rider because they were unwilling (intentional) or unable (unintentional) to participate. Results suggest that children negatively evaluate characters who free-ride in both environmental and non-environmental scenarios. We also found that intentionality affected children's judgments for non-environmental scenarios, but not ones dealing with the environment. That is, children evaluate purposeful free-riders as especially bad, but only when the collective action does not relate to the environment. This study provides further evidence that children hold normative expectations for others and these expectations extend to environmental care and concern. This is especially important when considering that these concerns about the environment have emerged prior to formal schooling.

4-F-108 Children expect others to prefer homemade foods and goods

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Children value objects differently based on invisible features describing an object's social history (such as who owned the object). Here, we test whether children expect others to prefer homemade foods and goods, a potentially important type of social history. In two studies, 4-12-year-old children ($N=246$) saw children with 2 matched items (e.g., 2 cookies). Children learned that one item was made by a specific person and the other was made in a factory, and were asked which item the target child preferred. In Exp. 1, items were either made by the target child or their parent. In Exp. 2, items were either made by the target child or a person in their town. Children expected others to prefer homemade items (Exp. 1: $M=71\%$, $t(123)=9.97$, $p<.001$; Exp. 2: $M=65\%$, $t(121)=7.7$, $p<.01$). Age predicted this tendency (Exp. 1: $b=0.2$, $z=6.4$, $p<.01$; Exp. 2: $b=0.15$, $z=5.03$, $p<.01$). In Exp. 3 ($N=122$), item quality was manipulated: Homemade items were imperfect and factory-made items were pristine. Here, children did not expect others to prefer homemade items ($M=53\%$, $t(121)=1.67$, $p=.1$). There was an effect of age ($b=0.12$, $z=3.9$, $p<.01$) and an Item Type x Maker interaction ($b=1.79$, $z=6.49$, $p<.01$). Children were most likely to select the imperfect homemade item for parent-made nonfoods ($M=75\%$), then child-made items

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(food=54%, nonfood=53%), then parent-made foods ($M=32\%$). These studies suggest that children value items that people made themselves and considered item quality in their decisions.

4-F-111 What role do adults play in fostering creativity?

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Guided play is considered an optimal play environment for fostering a creative mindset as it offers more adult support than free play and allows for greater child agency than direct instruction (Hirsh-Pasek, et al. 2015). Does all guided play result in the same creativity outcomes? In this study, 97 4- to 6-year-olds built castles under direct instruction (DI), constrained guided play (CGP), or unconstrained guided play (UGP) conditions. DI children followed step-by-step instructions to build a castle, and an adult corrected their mistakes. In CGP, children built a specific castle without instructions, and an adult encouraged exploration and allowed mistakes. In UGP, children decided the castle design and directed building, and an adult encouraged exploration. Children's creativity was measured via a creativity task, where children had to explore objects and the Alternative Uses Task (Wallach & Kogan, 1965). We hypothesized that the two guided play conditions would result in more object exploration on the creativity task and originality on the AUT. There were significant main effects of condition for both object exploration, $F(2,94)=3.36$, $p=0.04$ and originality, $F(2,53)=7.25$, $p<0.01$. The CGP condition had the highest mean scores for both object exploration ($M=10.38$; $SD=1.77$) and originality ($M=7.59$, $SD=5.11$). Children in the UGP explored the same number of objects ($M=9.28$, $SD=2.00$) as children in the DI condition ($M=9.21$, $SD=2.25$), but they had lower originality scores on the AUT (UGP $M=1.67$, $SD=1.67$; DI $M=5.92$, $SD=5.23$). Overall, constrained guided play seemed to enhance creativity, suggesting that adults have a role to play in supporting children's creative mindset.

4-F-112 Mistake or intentional?: Preschoolers' hostile attribution bias predicts their skepticism of inaccurate informants

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Although preschoolers are predisposed to trust other people (Csibra & Gergely, 2006), there is variation in children's trust. Others have demonstrated how individual differences in attachment (Corriveau et al., 2009) and parenting style (Brooker & Poulin-Dubois, 2013) affect children's trust. Here, we explored how personality differences, particularly hostile attribution bias - which is associated with negative perceptions of others (Dodge & Crick, 1990) - affect children's trust. Thirty-two 4- and 5-year-olds participated in a standard selective trust paradigm in which they were tasked with choosing between a previously inaccurate informant and a new informant they had not interacted with before. Hostile attribution bias was also measured. Children who avoided the inaccurate informant and preferred the new informant were also more likely to provide hostile intent evaluations in the bias task ($r = -0.329$, $p = 0.06$). Similarly, children who provided hostile intent evaluations more than 2 times out of 4 selected the new informant more than would be expected by chance, $t(22) = 2.64$, $p = 0.015$ and more often than children who made fewer hostile intent evaluations, $t(29) = 2.46$, $p = 0.02$, who did not differ from chance, $t(7) = -1.18$, $p = 0.28$. Therefore, children with greater hostile attribution bias may also be less forgiving of inaccurate informants.

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4-F-113 Children's ability to navigate competitive contexts: The role of gender and socio-cognitive skills

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A crucial aspect of children's development is learning to navigate diverse contexts within their social world. Competitive contexts are unique in that one must attempt to perform well (i.e. win), but also maintain social relationships with peers or competitors. This study assessed how the context (win/lose) and children's socio-cognitive skills affected children's game play and communication with opponents. Four- to six-year-old children (N = 102) played a rigged game on an electronic tablet against fictional peers (who participants believed were real children). Children sent verbal messages to their opponents after receiving feedback that they had won or lost. Children's performance in the game improved after receiving feedback that they had won previous games, but did not improve after receiving feedback that they were losing. Girls with higher executive functioning abilities showed more improvement in actual performance after receiving feedback that they were winning. Better theory of mind abilities predicted better game play performance for both genders, regardless of perceived outcome. In a losing context, boys' messages to opponents on the final trial showed more pro-social content than girls. Moreover, girls became continuously less pro-social towards their opponents after feedback that they were losing. This research provides new insights into how gender and socio-cognitive skills influence pre-schooler's performance and social behaviours in a competitive environment.

4-F-114 Just ask Siri: Children's selective trust in Siri over a human informant

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We examined 4-6-year-old children's (N=77) preference in posing questions to a smart device (Siri) or a human informant. Children participated in three phases: 6 vignettes and 4 novel objects where children were invited to choose to ask a question of Siri or an adult. Finally, children were given an explicit judgement question where they indicated whether the adult or Siri was "better" at answering questions. No age group displayed a preference for either informant for the vignettes or novel objects. However, 5- and 6-year-olds were more likely to judge Siri as "better" at answering questions ($\beta = .37$, $SE = 0.13$, $p < .01$). Children who justified their response by noting Siri's knowledge/omniscience (e.g., "Siri knows everything?") were more likely to judge her as "better" $\chi^2(1, N = 77) = 4.19$, $p < 0.05$). The findings provide insight into how children view smart devices as credible sources of information.

4-F-115 Children's beliefs about gender predict prejudice towards gender-nonconforming peers

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The current research investigated whether children's beliefs about gender relate to their preferences for more or less gender-stereotypic peers. To test this question, we recruited 82 children (6-10 years old) who completed three tasks: a task examining traditional gender essentialism (e.g., believing boys and girls are distinct, that gender is inborn, etc), a measure of the stability of one's internal sense of gender identity (e.g., believing a boy who feels like a girl will continue to feel like a girl in the future), and an assessment of prejudice towards gender-nonconforming (vs. gender conforming) children. Multiple

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linear regression analyses indicated that our model--with gender essentialism and gender identity stability as predictors of prejudice--was significant, $R^2 = 0.223$, $F(2,80) = 11.10$, $p < .001$. Participants higher in gender essentialism showed higher levels of prejudice towards gender-nonconforming children ($\beta = 0.465$, $p < .001$). Beliefs about the stability of gender identity did not predict prejudice ($\beta = -0.046$, $p < .651$). These findings demonstrate that prejudice towards gender-nonconforming peers may be explained in part by individuals' beliefs that gender (whether one is a boy or a girl) is biologically based, informative, discrete, and immutable. Because this study was correlational, a next step is to test the causal role of essentialism through a formal experiment.

4-F-116 The influence of bilingualism on children's development of conventional understanding

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Both morals and conventions make up our social knowledge (Turiel, 1983). While both domains include rules that individuals should follow, children and adults recognize that transgressing moral values is more serious than transgressing social conventions (Smetana, 2006). Yet, not much is known as to which types of experiences play a role in the development of such knowledge. This study examined whether language experience influences the way children evaluate moral and conventional transgressions. Given language is highly conventional (Kalish & Sabbagh, 2007), and bilingualism can affect children's understanding in different domains (Byers-Heinlein & Garcia, 2015), we hypothesized that bilinguals recognize the conventional nature of language and generalize this flexibility to other domains of conventional knowledge. We presented four- to six-year-old monolingual and bilingual children with vignettes of moral (e.g., hitting), social (e.g., wearing pants on one's head), and language (calling a common object by a nonsense word) behavioral transgressions, and asked about their permissibility. We predicted that bilinguals would be more permissive of language and social norms than monolinguals, but that bilingualism would not impact judgments about moral violations. Surprisingly, bilingual children were more permissive of violations of language, social and moral norms. The findings provide striking evidence that social experience in the language domain can affect children's understanding of a wide range of domains, altering the way children think about both conventions and morals.

4-F-117 Young children's understanding of joint commitments in collaborative endeavours

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A joint commitment is a mutual obligation among individuals in a collaborative enterprise. That is, the individuals recognize themselves as working together towards a common goal, and they expect each other to be earnestly devoted to fulfilling their part to achieve that common goal. Furthermore, once one has committed oneself one ought not turn away from the obligation going along with the commitment as one chooses. Just as joint commitments are made by agreement, properly dissolving them should involve an agreement, an excuse or some other respectful act such as a notification between collaborators. Across three studies, we investigated 3- and 5-year-olds understanding of joint commitments. The first study, explored 3-year-olds' ($N = 144$) reactions to a partner's failure to perform their role in a joint commitment. Children showed more protest against a partner who defected selfishly and knowingly, but restrained from protest if a partner stopped cooperating due to a reason outside of his control. Interestingly, they also tried to teach their partner if he appeared willing but incompetent.

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Second, we asked whether 3- and 5-year-olds could be bribed to abandon a collaborative partner. That partner was either someone with whom the child verbally agreed to collaborate (explicit joint commitment), someone who depended on the child to succeed in the collaborative activity (implicit joint commitment), or a partner who could play independently. Participants were dyads of 3-year-old and 5-year-old children ($N = 192$). We found that children of both age groups uphold their commitment to the partner and resisted attractive alternative individual rewards if an explicit joint commitment was formed. However, only at the age of 5 children seemed to interpret a partner's dependence as a binding obligation and were more likely to resist bribes both after an explicit commitment and if there was only an implicit commitment to their partner. Third, we investigated whether children understand an essential aspect of joint commitments - how they may be dissolved. We presented 3- or 5-year-old children ($N = 144$) and a puppet partner with a collaborative task that they both had agreed to work on together. In three conditions, we manipulated how the puppet disengaged from the joint commitment and explored children's reactions to the partner's disengagement depending on how it was dissolved. In particular, we measured children's protest behavior while the puppet partner was leaving the game, how long it took children to start to play by themselves and children's assessment whether the puppet deserved scolding or a reward. In the Dissolved condition, the puppet stated a reason why she had to go and asked children's permission to leave. In the Notify condition, the puppet only stated the reason and left. Lastly, in the Just-leave condition, the puppet left without saying anything. Results indicate that children of both age groups understood commitments as binding and protested against and resented a partner who just left the task or did not dissolve appropriately. After a proper and joint revocation, children rarely protested, were quicker to start playing alone and didn't resent their partner. Based on these findings, we conclude that starting at 3 years of age, children are not only able to coordinate and cooperate with others in joint tasks, but also understand one of the basic building blocks of human societies: joint commitments.

4-F-118 The development of wealth stereotyping

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Children attend to cues to individuals' wealth status, yet it remains unclear what traits, knowledge, and abilities children associate with wealth, as well as how these associations vary over development and based on experience. Here children ages 5-10 ($N = 224$) in rural Arkansas and upstate New York learned about target children who varied in their wealth status, as well as whether they were depicted as being from urban versus rural environments. Participants were asked which target(s) are hardworking, nice, and smart; they were also asked to make inferences about the targets' knowledge and behavior. Participants associated intelligence with wealthy targets, whereas they associated being hardworking with poor targets. Younger participants associated niceness with wealthy targets, but with age, participants became increasingly likely to associate niceness with poor targets. Further, participants associated some knowledge states with different targets. Ongoing research is testing whether these effects extend to children living in urban areas, and whether children's family socioeconomic status relates to their responses.

4-F-119 Do 18-month-olds revise attributed beliefs?

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We propose two possible routes by which belief attribution might be performed: prospectively, during the observation of belief-inducing situations, or in a retrospective manner, based on episodic retrieval of the details of the events that brought about the beliefs. We developed a new task to disentangle the contribution of the above two processes: we tested whether children could revise an attributed FB when they subsequently learned that the agent could have witnessed the situation that they initially thought had not been perceived by her. 18-mo-olds observed two novel objects hidden by Experimenter 1 (E1) into two boxes. Then E1 left the room, and while she was away, the location of the objects were swapped. Infants were then asked to accompany Experimenter 2 (E2) to the adjacent room to invite E1 back. When they entered the room, infants in the FB-TB condition observed E1 peeking into the experimental room through a one-way mirror, while in the FB-FB condition she was reading and the window was covered. In a third condition (FB condition), the children did not leave the room. When E1 was back, she requested an object from the children by pointing to one of the two boxes. In response to the request of E1, 15 of the 17 infants chose the non-referred box in the FB-FB condition (which included an intervention without requiring belief revision). However, in the FB-TB condition, in which they witnessed E1 peeking through the one-way mirror, 13 of the 15 children chose the referred box). Our results suggest that 18-month-olds can update an already attributed false belief after having learnt that the agent could have witnessed the change of the location of the object.

4-F-120 How you say it matters: Children's evaluations of speakers based on register use

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Registers are clusters of speech variations deployed in a given social situation. For example, Baby Talk is a commonly used register spoken to babies marked by exaggerated, melodic, and simplified speech. Previous research suggests children and adults are sensitive to register as a source of social information about a register's recipient. However, registers also vary as a function of speaker; speakers differentially use registers depending on who they are and to whom they are speaking. For example, when talking to the principal of a school, someone might speak more formally if they are a subordinate (e.g., a teacher) than they would if they were a superior (e.g., superintendent). Indeed, if someone were to talk to a superior as if they were a subordinate, that speaker may be perceived as rude. This study investigates whether children use register to differentially evaluate speakers. In this study, 5-8-year-olds (N = 42; target N = 72) and adults (N = 12; target N = 50) are tested on whether they rate speakers differently based on the register they use and who they address it to. Participants see a series of four speakers, two of whom use Baby Talk and two of whom use Teacher Talk (polite, teacher-directed speech). In half the trials, speakers match their register with their addressee (i.e., Baby Talk directed to a baby; Teacher Talk to a teacher). In the other half, speakers have a mismatch with their addressee (e.g., Baby Talk to a teacher). Participants rate each speaker on dimensions of warmth (liking, niceness) and competence (smartness) on a 6-point scale and make predictions about the relationship between addressee and speaker along the same dimensions (warmth = friendship; competence = who is in charge). Data collection is ongoing, and a mixed-models regression with age, register, and addressee as fixed factors and participant as a random factor will be conducted for the final analyses. Preliminary data from adults suggest they attend to both the register a speaker provides and how well it matches its addressee when evaluating speakers (see Table). For example, adults report liking speakers who use Teacher Talk more than those who use Baby Talk, but for both Teacher Talk and Baby Talk, they report liking the speaker whose register matches their addressee more than the speaker whose register does not. Children

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likewise appear to evaluate speakers based on the register they use, providing lower ratings for speakers who use Baby Talk than Teacher Talk. However, they do not seem to attend to whether a register matches its addressee as much as adults. For example, children rate speakers who mismatch Baby Talk with a teacher lower compared to those who use it with a baby but do not seem to penalize speakers who use Teacher Talk with a baby instead of a teacher (see Table). Together, these preliminary data suggest that children are sensitive to the register a speaker deploys when evaluating them but that their attendance to how well it fits the speaker's addressee is still developing compared to adults. This sets the foundation for future research to consider how register may provide social information to children. For example, how do children track the register choices a person makes over time and use those choices to inform social inferences about them? Answering such questions can help us better understand how children attend to the rich linguistic cues provided by register to learn about the social world around them.

4-F-121 Lowering expectations at the moment of truth: Children's and adults' beliefs about how the timing of expectations influences emotions

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We tested 8- to 10-year-olds' and adults' (current N = 74; planned N = 100) beliefs about the connection between expectations and emotions across time. Characters held high or low expectations at the moment of learning about the event (Time 1; e.g., after finding out that there would be a raffle) and then their expectations changed right before learning the outcome (Time 2; e.g., right before finding out the outcome of the raffle). For example, at Time 1, the first character thinks, "I'm pretty sure I'm going to win" and the second character thinks "I'm pretty sure I'm going to lose." Then at Time 2, the first character now thinks, "I'm pretty sure I lost," and the second character now thinks, "I'm pretty sure I won." Participants reported how characters would feel using a 7-point pictorial scale (from "very bad" to "very good") after three outcomes: positive (e.g., "They won a big prize"), negative (e.g., "They got nothing"), and attenuated (e.g., "They got a small prize"). Data collection is ongoing, but we expected that children and adults would judge that proximal expectations (Time 2) have a stronger influence on post-outcome emotions than distal expectations (Time 1). More specifically, we anticipated that children and adults would report that characters at Time 2 who have low expectations would feel better after outcomes than characters who held high expectations at Time 2. We also hypothesized that there would be age-related differences in recognizing the emotional benefits of low expectations. That is, we predicted that adults would judge the expectations to have more shaping power on emotions than would children.

4-F-122 Let me do it myself: The relationship between intrusive behavior in adults and young children's persistence

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Children's persistence in the face of challenge is central to learning, yet research on how parents and adults can help foster young children's persistence is scarce. Here, we explored how parent and adult behavior causally impacts preschool-age-children's persistence. First, we examined which parenting behaviors, elicited during a parent-child interaction task involving challenging puzzles, related to trait persistence in 34 4-8-year-olds. Intrusive parenting behavior, operationalized as taking over during the

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puzzle task, was negatively associated with children's persistence ($B = -.31$, $p = .04$, controlling for age, SES, gender, and race). To establish the causal direction of this relationship, we ran a pre-registered experiment where 4-5-year-olds were randomly assigned to an "taking over" condition, where the experimenter was intrusive and solved puzzles for children, a "teaching" condition, where the experimenter helped scaffold puzzles for children, and a no manipulation "baseline" condition ($n = 88$). Children persisted less on a subsequent novel toy in the "taking over" condition as compared to both the "teaching" condition ($p = .001$) and "baseline" ($p = .03$). These data suggest that allowing children to struggle with challenging problems, rather than solving the problems for them, promotes persistent behavior.

4-F-123 The effects of group membership and social exclusion in children's testimonial learning decisions

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Empirical work on testimonial learning has largely focused on the development of epistemic trust, and tends to encourage a risk-assessment picture of learning while shielding from view the social dimensions of testimonial transactions (Jaswal & Kondrad, 2016; Koenig & McMyler, 2017). This study explored the influence of two social factors on children's trust: group membership and social ostracism. After being assigned to a color group, 4-to 5-year-old children ($N = 104$) were either included or excluded by three in- or out-group members in an online ball-tossing game (i.e., Cyberball, Williams et al., 2012). In the selective learning task that followed, children were more likely to trust an in-group member for new information after having been excluded rather than included in the Cyberball game ($F(1, 96) = 4.385$, $p = 0.039$). However, when children were presented with counter-intuitive claims (e.g., claims that a shorter line was the longest line), they were more likely to defer to an in-group member's testimony, regardless of whether they were previously ostracized or not ($F(1, 96) = 7.233$, $p = 0.008$). These findings suggest that children's testimonial learning may be guided by social goals such as the desire to belong, and inclinations to conform or maintain positive relationships with others. Thus, it is important to investigate the types of social influences that feature in children learning decisions.

4-F-124 Attentiveness and involvement in parent effortful behavior relates to children's persistence

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Recent work has shown that children try harder after watching adults try hard at a task and succeed (Leonard, Lee, & Schulz, 2017; Leonard, Garcia, & Schulz, in press). This effect is amplified if the adult engages the child pedagogically (e.g. using eye contact, child direct speech). However, whether parents genuinely involve children in their effortful struggles, and how this might relate to their children's persistence, remains an open question. Here we coded parent behaviors as they attempted a challenging origami task in front of their child ($n = 32$, ages 4-8). When parents involved their children more in the origami task, their children paid more attention ($r(29) = .54$, $p = .002$, controlling for age and SES). Child involvement and child attention were both positively correlated with persistence on a separate task that children completed independently (trying to open an impossible puzzle box) (child involvement: $B = 15.0$, $p = .003$, child attention: $B = 15.7$, $p = .03$, controlling for age and SES).

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Complementary to previous work, we found that involving children in adult struggle relates to higher persistence in a more naturalistic family context.

4-F-125 Persistence in science after making mistakes: investigating language effects on engagement and motivation in the early childhood classroom

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In a series of studies, Rhodes et al (2019) have reported findings indicating that talking about science in terms of actions rather than identity increases girls' persistence in science games and thus might represent a potential intervention for supporting girls' earliest engagement and motivations around science. This study is an experimental investigation in early childhood classrooms in Ireland of the effects of action versus identity based language on children's persistence during a science game and their sense of enjoyment of the science game. Participants were 134 children (70 boys, 64 girls; mean age of 6 years 1 month; age range of 4 years 11 months to 7 years) who were tested in three urban public primary (elementary) schools. Preliminary inspection of the data indicates high levels of persistence across both conditions for both genders but with slightly greater persistence among boys in the identity-based condition supporting recent findings in both classroom and real-world contexts.

4-F-127 Says who? Children consider informants' sources when deciding whom to believe

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Often, others' claims arise not from firsthand experience, but from the past testimony of their own informants. When evaluating these claims, do children attend to their source's sources, following a chain of testimony back to its origin? In two experiments, 4-7yo's (N = 240) heard a story about a teacher trying to find the class hamster. In Experiment 1, the teacher asked two students where the hamster was, and each student endorsed a different location. Participants learned that one student's opinion was based on that of a consensus: three other students told her they saw the hamster there. In contrast, the student who endorsed the other location had heard from just one source (Figure 1a). 5-7yo's endorsed the testimony of the consensus-supported student; by age 5, children seem to value more witnesses over fewer (Figure 1c). In Experiment 2, the design was identical except that a group of three students initially endorsed each location (Figure 1b). One group based their testimony on that of a consensus, and the other on just one source. In this experiment, participants had to ignore the superficial "consensus" within each initial group, and attend to their sources. Here, only 6-7 yo's endorsed the testimony of the consensus-supported group (Figure 1d). These results demonstrate that while even young children are sensitive to some social features that make for a helpful informant, not until age 6 do children look beyond an initial (apparent) consensus to evaluate sources.

4-F-128 Preschoolers are cautious about extending group traits to unfamiliar group members

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Do preschoolers make predictions about people's future behaviors based on their group membership? A previous study showed that 4- and 5-year-olds expect strangers to be as knowledgeable as their group ("red" group), but only when group membership was explicit, ("she's part of the red group"); they never

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generalized niceness (Norris & Konrad, in prep). In the present study, the red/blue groups' traits are now explicitly labeled: smart/not smart ($n=15$), or nice/not nice ($n=14$). Four- and 5-year-olds saw the red and blue groups demonstrate their knowledge or niceness and heard their traits labeled. Children then identified which of two strangers, wearing either red or blue, was right about novel labels or did the nice novel action. Figure 1 shows that 4-year-olds expect strangers to be nice like their group, $t(6)=3.06$, $p=.022$, $d=1.16$, but did not expect them to share the knowledgeable trait. Five-year-olds never used group trait labels to make inferences about strangers' epistemic or social traits, $t_s < 0.68$, $p_s > .520$. Although both ages use general group membership labels (red) to make inferences about strangers' knowledge, only younger children use trait labels, and only for a social trait (niceness). Older children are especially cautious about using group trait labels of any sort to judge strangers if they do not have direct evidence upon which to base those expectations.

4-F-129 Groups as institutions: The use of constitutive rules to attribute group membership

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Across four experiments we tested children's ($N = 229$, aged 4-9) beliefs about what makes an individual a member of a group. One model (groups as institutions) predicts children believe groups are based in constitutive rules, i.e. collectively agreed-upon rules that ground membership. Another model (groups as social network) predicts children believe groups are based in patterns of social relationships. We tested whether and to what extent children rely on constitutive rules to attribute group membership. We found that young children can reason about constitutive rules as a means of becoming a group member, and their reasoning about constitutive rules is relatively sophisticated (Study 1-3). But, when constitutive rules are pitted against friendship, young children (4-5) prioritize friendship and older children (6-9) prioritize constitutive rules. Therefore, both models contribute to the understanding of children's concepts of social groups across development.

4-F-130 Associations between child characteristics and interpretation of communicative intent

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The ambiguity of language, particularly figurative language, requires individuals to integrate contextual information and speaker cues to fully appreciate the intended meaning. There is a paucity of work investigating how children's characteristics interact with contextual factors to influence interpretation of statements. The present study examined how children's shyness and negative peer experiences influence their interpretation of literal and ironic statements, and whether interpretations may differ according to a speaker's social status. Children (8- to 10-year-olds; $N=44$) participated in a first-person task that situated them within a communicative exchange with (virtual) players. After completing a rigged card game, participants were given feedback on their performance from another player (described as high/low social rank) that was a literal/ironic compliment or criticism. Literal statements were comprehended better than ironic statements and irony muted the intended meaning of the statements, but only for compliments. However, the social status of speakers did not affect children's interpretations. Participants' negative experiences with peers (but not shyness) was associated with their interpretations of messages: children who reported increased relational aggression perceived more negative speaker attitudes. In contrast, children who experienced more overt aggression rated critical speakers as being more positive and as having higher friendship potential.

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4-F-131 Infants generalize beliefs to naïve agents

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Theory of mind (ToM) is the attribution of mental states, such as beliefs, desires, or intentions to oneself and others. With the use of explicit tasks, it was originally believed that this ability emerges at 4 years of age. However, the mentalistic view of ToM understanding posits that infants possess a sophisticated understanding of beliefs when measured by spontaneous-response tasks. Such mature concept should include the understanding that beliefs are person-specific and therefore, should not be generalized to others. It is, however, unknown whether infants have such understanding about beliefs. To test this, the present study used a switch agent paradigm with the classic violation-of-expectation task. The results demonstrated that 16-month-old infants in the incongruent group looked longer than those in the congruent group, thus attributing both true and false beliefs to a naïve agent. These findings suggest that infants generalize beliefs across agents and thus do not possess a sophisticated understanding of ToM.

4-F-132 A coordinated movement approach to reducing children's implicit and explicit racial biases

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Although racial biases have been extensively studied (Lai et al., 2014; Pascoe & Smart Richman, 2009), little is known about how they can be reduced in children. To fill the gap, we developed and tested coordinated movement, which involves exercising with other-race individuals shown on video. This strategy was built on two strategies that have previously proven effective: individuation training, in which participants practice the process of treating racial outgroup members as unique individuals rather than members of social groups, and indirect contact, in which participants interact with racial outgroup members without face-to-face. In our study, 5-year-old children in China (N = 63) performed exercises led by four Black individuals in two 30 minutes sessions that were one week apart. We found a long-term reduction in both explicit and implicit anti-Black biases which lasted for 17 weeks. A control condition showed that the same exercise performed with Chinese individuals had no significant effects. This suggests that our coordinated movement activity, which can easily be incorporated into educational settings, can be used on a large scale to lead to lasting reductions in racial bias.

4-F-134 Stuck in a bubble: Children expect others who rationally misreport base rates to update their beliefs with more information

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To a certain extent, learners are stuck in a bubble of limited information about the state of the world. Limited information may lead a learner to make a false, yet rational conclusion that is based on the data available to them (a "rational misreport"). In such instances, we may hold the intuition that this person will update their beliefs given more information. On the other hand, we may not expect someone who misreports information from the data available to them (an "irrational misreport") to rationally revise their beliefs. We tested this idea with children ages 6-12 years (N = 19). Children observed an image of

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an ocean in which there were more turtles than clownfish (seven vs. two), but the target character, James, reports that there are more clownfish. In the Rational Misreport condition, children observed James swimming in an area in which there was a large piece of kelp blocking his view of the other five turtles, such that he could only see two clownfish and one turtle. In the Irrational Misreport condition, children observed James swimming over all seven turtles and two clownfish. When asked why James said there were more clownfish, children were significantly more likely to say that it was because he lacked complete information in the Rational Misreport condition (70%) compared to the Irrational Misreport condition (18%). Notably, when children were told that James went swimming again over the entire part of the ocean, 100% of children in the Rational Misreport condition said James would now say that there were more turtles, while only 45% of children in the Irrational Misreport condition said that he would update his beliefs.

4-F-135 Preschoolers make retrospective inferences in their selective trust choices

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Preschoolers learn selectively from others based on the speakers' prior accuracy. This indicates that they recognize the models' (in)competence and use it to predict who will provide the most accurate and useful information in the future. Here, we investigated whether 5-y.-o. children are also able to use speaker reliability retrospectively, once they have more information regarding their competence. They first experienced two previously unknown speakers who provided conflicting information about the referent of a novel label, with each speaker using the same novel label to refer exclusively to a different novel object. Following this, children learned about the speakers' differing labeling accuracy. Subsequently, children selectively endorsed the object-label-link initially provided by the speaker who turned out to be reliable significantly above chance. Crucially, more than half of these children justified their object selection with reference to speaker reliability, indicating the ability to explicitly reason about their selective trust in others based on the informants' individual competences. Findings further corroborate the notion that preschoolers are able to use advanced, metacognitive strategies (trait reasoning) to learn selectively. In contrast, since learning preceded reliability exposure and gaze data showed no preferential looking toward the more reliable speaker, findings cannot be accounted for by attentional bias accounts of selective social learning.

4-F-136 Who do kindergarten girls see doing science? Effects of females in STEM classroom visits

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Research suggests that when using action words (Do Science) rather than identity-focused words (Be Scientists), girls persist in difficult science-related games for longer (Rhodes et al., 2019). In an intervention study where female scientists visited elementary schools to engage in science activities but used identity-focused words, there was no effect on children's gendered perceptions of who a scientist is (Buck et al., 2002). To study kindergarteners' perceptions of who can do science, an intervention (INT) group received 30-minute interactive presentations from female graduate students once a month for 8 months, such as "To learn about the science we do, we're going to play a guessing game". Children then identified objects under a microscope. We compared them to a control (CON) group on their choice of who is most likely to be smart, be a scientist, or do science from gender balanced photo arrays of 2 or 4

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people. Groups didn't differ on SES, age, or screening questions, and had similar gender ratios (INT: F=11, M=13, Age=75.8 mo.SD=8.6; CON: F=13, M=10, Age=73.9 mo.SD=3.7). After 8 visits, INT group girls were more likely to choose females vs males for 'do science' questions ($t(21)=-3.369$, $p=0.005$), CON group girls were not ($t(22)=-1.727$, $p=0.098$). There was no effect on other question types. In conclusion, exposure to female scientists was influential only when paired with action-oriented words, an important consideration for future intervention work on this topic.

4-F-137 Individual differences in preschoolers' selective learning from ignorant speakers

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Preschoolers learn novel object labels and functions from a previously ignorant speaker when she is the only available informant (Kushnir & Koenig, 2017). However, when another informant is available, children avoid learning from the ignorant speaker in the same domain as her previously professed ignorance (labels) and demonstrate no informant preference in a different domain (functions; Varhol, Kushnir, & Koenig, 2019). We explored how 65 preschoolers' (42.0-58.7 months, $M = 48.74$, $SD = 4.51$) learning from the ignorant speaker was related to individual differences in their social cognition (CSUS; Tahiroglu et al., 2014) and parent authoritarianism (Tagar et al., 2014). Children with better perspective-taking scores were more avoidant of her novel labels ($r = -.274$, $p = .043$). Although children learned novel functions from the ignorant speaker at chance, those with more authoritarian parents were less likely endorse her function claims ($r = -.292$, $p = .031$). These correlations provide new insight into the potential roles of social cognition and home environment in selective social learning and in the development of children's evaluations of knowledge and ignorance.

4-F-138 Children's information sharing with a naïve listener in an open-ended task

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Preschoolers can teach others what they have learned (e.g., Ronfard, Was, & Harris, 2016) and they are selective about the type of information they share with naïve or knowledgeable listeners (Baer & Friedman, 2018). They also show more trust in information provided by a previously accurate speaker than an inaccurate one (e.g., Koenig, Clement, & Harris, 2004). We examined what information children ages 4 to 6 ($n = 43$) share with a naïve listener after hearing testimony from previously accurate and inaccurate informants. Informants provided conflicting information from four different domains (Physical Science, Life Science, Mathematics, and Object Labels) and children had an open-ended opportunity to share what they learned with a naïve listener. Responses were transcribed and coded by two independent raters (92.86% agreement). Children were more likely to share information from the accurate informant than the inaccurate informant. However, they shared information from the accurate informant on only about 38% of trials overall (see Figure). Thus, the results suggest that although children may selectively endorse information received from a previously accurate informant over an inaccurate one, they do not necessarily share information received from a previously accurate informant with a naïve listener. Children may also find it particularly challenging or be reluctant to share information about object labels, relative to information from STEM domains.

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4-F-139 Only children and children with siblings exhibit differences in kin altruism

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The present study investigated the differences between only children and children with siblings when allocating resources between recipients with different social relationships, e.g., siblings vs. strangers, friends vs. strangers, and siblings vs. friends. Four- to six-year-old children participated in a resource allocation task and an emotion judgment task. The results showed that there was an age effect in children's sharing choices, consistent with previous studies. Children from multiple-child families were more willing to share resources with a sibling over a friend than those from only-child families. Children with siblings felt sadder when non-sharing behavior happened with a sibling (including sibling over friend and sibling over stranger) than did only children. These findings suggest that the difference in kin-preference between only children and children with siblings is largely due to cultural factors and their respective life experiences.

4-F-140 Do eye contacts by infants provoke speech from parents?

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In dyadic conversation, gesture, gaze and verbal exchange are coordinated among individuals. Pointing gesture and initiating eye contact (EC) are often observed in social interaction between pre-verbal infants and parents. Although infants' pointing provoke parents' speech to infants, little is known about whether infants' initiating EC has the same effect as pointing. Using head-mounted eye trackers worn by parents, we recorded infant-parent daily face-to-face interactions longitudinally with 5 infants aged from 10 to 15.5 months. By categorizing EC as either infant-led EC or parent-led EC, we investigated per day whether the high infant-led EC proportion was associated with more parental speech to infants. The results of the state space model revealed that the proportion of infant-led EC increases the parental speech frequency by 84%, which was not a clearly detected effect. It may be necessary to explore the relationship between infant-led EC and parental speech in each interaction unit, rather than in observational days.

4-F-141 Can gendered robots change children's gender stereotypes?

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Children treat robots as social actors and sources of social information in selective trust, Asch conformity, moral reasoning, and social modeling paradigms. Here we ask if children use gendered robots as sources of information about stereotypes, culturally held beliefs about human social groups. Forty-five 6- to 8-year-olds participated in a short counterstereotyping task. Children in the counter-stereotyped condition viewed videos of female gendered robots with culturally stereotyped masculine occupations, traits, and activity interests (e.g., a female truck driver robot that is brave and likes to build with tools). Children in the stereotyped condition viewed videos of female gendered robots with culturally stereotyped feminine attributes (e.g., a female secretary robot that is affectionate and likes cheerleading). Children completed a measure of gender stereotyping before and after viewing the intervention videos. From pretest to posttest, children's gender stereotypes decreased in the counter-

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stereotyped condition and increased in the stereotyped condition. These findings suggest children treat social robots as models for cultural gender stereotypes. This is both hopeful and worrisome.

G – Cognition in diverse environments

4-G-142 Children's reflections on tinkering experiences in a children's museum

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This project focused on what young children report about their experiences shortly after visiting a tinkering exhibit in a children's museum. What children report about their experiences immediately after them can provide information about what was encoded and initially learned. We interviewed a total of 489 children (M age = 6.61; 46.2% girls) in the museum exhibit after they engaged in one of three tinkering programs: Make Something that Does Something, Make It Fly, or Make It Roll. Whereas all three programs posed an engineering design challenge, the latter two programs also included spaces in the exhibit where children and families could test their creations, i.e., wind tunnels, ramps, in Make It Fly and Make It Roll, respectively. Immediately after children finished tinkering, we invited them to take a picture of what they made with a tablet computer, and to tell us what they did and learned using a series of open-ended prompts. Compared to children who visited when there were no designated spaces to test, children who visited during programs with spaces to test (Make It Fly and Make It Roll) talked significantly more about engineering when reporting their experiences immediately after tinkering. These results provide insight into activities that can support children's engineering learning during tinkering, as well as ways to assess this learning in informal educational environments.

4-G-143 The effect of color, shape, and virtual agent in a text-based Mandarin-vocabulary game on adults' affect and learning performance

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This research investigated how the color, shape and virtual agent of a 2D text-adventure game for HSK (a Mandarin standardized test) vocabulary learning influence adults' affect and learning performance by implementing a 2*2*2 factorial experiment. The results showed that adult HSK learners had shorter reaction time when memorizing Mandarin vocabulary for the cool-color interface ($p < 0.01$) and the square-shape design ($p < 0.01$) compared to the warm-color interface and the round-shape design, but there were more participants feeling positively for the warm-color interface (58.82% of participants) and the round-shape design (55.88% of participants). Additionally, the effect of the virtual agent on learning performance was not significant ($p = 0.314$). The results are consistent with emotional design theories in that design elements are associated with learners' emotions and learning performance, but a cultural variation with the effects of game-design features on learners' emotions and learning results were also found.

4-G-144 The relation between children's media use and growth in language and literacy skills

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Children spend over 2 hours a day with media and time spent using mobile devices tripled from 2013 to 2017 (Commonsense Media, 2017). Media use could be detrimental to children's language and literacy skills because it may displace other literacy-enhancing activities like shared reading and decrease the quantity and quality of caregiver-child interaction (Khan et al., 2017, Vandewater et al., 2005). Indeed, studies have found that media exposure is associated with lower language development (Pagani, 2013), as well as lower educational achievement in adulthood (Hancox et al., 2005). However, findings are inconsistent, with other research finding no association between media and these outcomes (Schmidt et al., 2009). Furthermore, much of this literature has focused on infants, toddlers, and preschoolers, with less focus on older children. Because language and literacy skills develop rapidly in early childhood, one might predict that media use would be more detrimental in early childhood than during the elementary years. We examined the relation between children's media use and language and literacy growth across a school year. Children (N = 2060) were from preschool through third grade classrooms in two school districts in Ohio. Language skills were measured using the Letter-Word Identification and Picture Vocabulary subtests from the Woodcock Johnson IV Test of Early Cognitive and Academic Achievement. W-scores were averaged to form a composite language/literacy skill measure. Parents reported whether their child watches video and plays electronic games on a typical school day and, if so, for what amount of time. Parents reported that 72% of children both watch videos and play games on a typical school day, with an additional 22% watching video but not playing games. Only 5% of children were reported to not use any media on a typical school day. Of those who do use media on a typical school day, 39% use media for 0 to 1 hours and 61% use media for 2 or more hours. Regression analyses were conducted with children's language/literacy composite score in the spring as the dependent variable controlling for fall score to measure change. The model also controlled for age, gender, race, mother's education, and number of adults in the household. Children who used 2 or more hours of media on a typical school day had significantly lower language/literacy growth than children who used 0 to 1 hours of media per day ($B = -.82$, $p = .014$). There was no interaction between age and screen media, $p = .40$. These results highlight the prevalence of media in children's lives and suggest that increased media exposure may be negatively related to growth in children's language and literacy skills, even after the early childhood years. Time spent with media may displace other activities, such as book reading, homework, or interactions with peers and parents. These findings highlight the importance of considering media exposure as part of the home literacy environment. Ongoing research is assessing whether the content and context of children's media use moderates the relationship between media exposure and language and literacy growth.

4-G-145 Relations between executive function and theory of mind: Taking a deeper look at low-income, at-risk preschoolers' cognition

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The preschool years are critical for the development of children's executive functions (EF) and theory of mind (ToM). Prior literature shows a robust relationship between EF and ToM (Baker, D'Esterre, & Weaver, 2019); however, few studies have explored these phenomena within low-income, at-risk preschoolers, who tend to perform differently on tasks of EF and ToM (Shahaeian, et al., 2015). Recently, researchers have begun to consider how exposure to adverse life events shape cognitive capacities including highlighting positive stress adaptations (Frankenhuis & de Werth, 2013), such as enhanced emotional awareness and memory (Ayoub, et al., 2006) and reasoning (Schliemann &

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Carraher, 2002). The current study had two goals. First, examine whether low-income children differ from peers in terms of acquiring ToM, and if this differs for emotionally-salient ToM ("hot") versus ToM which do not involve emotional perspective taking ("cold"). Second, examine the relations between hot and cold EF and ToM among low-income children. We hypothesize that children from low-income families will perform above average on "hot" tasks (that is, those which require or engage an affective consideration) compared to "cold" tasks, and that "hot" ToM tasks will be best explained by "hot" EF tasks compared to "cold" EF tasks. 130 3- to 5-year-old children (Mage = 46.05 months, SD = 9.21) enrolled in an urban Head Start education program completed the Whisper task (Reck & Hund, 2011) and the Day-Night Stroop task (Gerstadt, Hong, & Diamond, 1994) which provide "hot" (i.e., emotionally salient), and "cold" measures of EF, respectively. Children also completed a 5-task ToM battery, including the Real-Apparent Emotion task (Wellman & Liu, 2004). Additionally, verbal skills were measured by the Peabody Picture Vocabulary Test -Version 4 (Dunn & Dunn, 2007). First, comparing ToM passage rates reported in previous studies using non-disadvantaged preschoolers (Baker, D'Esterre, & Weaver, 2019; Wellman & Liu, 2004), children in the current study passed the Diverse Belief task (37.8%), and False Belief task (38.9%) at lower rates ($p < .01$), and passed the Diverse Desires (72.5%) and Knowledge Access task (56.7%) at comparable rates ($p > .05$). Children in the current study performed at a slightly higher rate on the Real-Apparent Emotion task (33.7%; $p < .05$). Overall, this indicates that stress-adapted children's ToM does not develop or emerge in the same pattern as that of non-stress adapted children, and suggests that they may have enhanced emotional mental state understanding. Importantly, the likelihood of passing several ToM tasks was best explained by the "hot" EF task (Whisper Game; $.10 > R^2 > .07$, $p < .01$), indicating that emotionally-salient inhibitory control may be more relevant in explaining these children's mental state understanding. Overall, these findings suggest that stress-adapted children's cognitive advancements may not follow the patterns reported previously using more affluent samples, indicating that mental state understanding may develop as adaptive for the environment. In concert with cross-cultural research on EF and ToM, these findings suggest that ToM development can be impacted, both positively and negatively, by environmental factors. Limitations and future directions will be discussed.

4-G-146 The effect of multimedia features on young children's E-book reading

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Previous studies showed that the effect of e-story book reading for young children's literacy development was debatable (Bus, Takacs, & Kegel, 2015; Miller & Warschauer, 2013; Takacs, Swart, & Bus, 2015). To further explore these questions, a story named Winnie the Witch was used as learning materials, and iPad was used to present the story in this study. Three experiments were used to investigate the effect of the interactive element and multimedia features in e-story book reading. The results suggested that children in e-story book condition showed more interests and worse comprehensions; The interactive element in e-story book condition has negative effect on children's understanding of the story; children's recall scores, comprehensions and the interests of stories with animated pictures were higher than those without animated pictures; children showed more continue-reading tendency when presented music with animated picture. In conclusion, e-story book without interactive element and with animated pictures could facilitate young children's book reading.

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4-G-147

Up in the Airways: Linking explaining and exploring to children's causal

thinking

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Explaining and exploring have been suggested to benefit learning, yet less is known about links between explanation and exploration, or how they predict children's causal thinking. We examined parent-child activity at a museum exhibit to understand how explaining and exploring relate to children's causal thinking about the properties of air. Families were given five minutes to participate in free-play at an exhibit called Airways. After the free-play, children engaged in challenge activities with a researcher to get a sense of children's causal thinking about air. Unlike previous work, these follow-up challenges were presented at the exhibit rather than in a separate "test-like" session. Children were asked one non-verbal ("can you make the ball come out of this tube?") and one verbal question ("what does this switch do?") related to the causal mechanism of the exhibit. Predictors included the frequency of explanatory statements and questions by parents and children, as well as the frequency of parents' and children's exploratory actions at the exhibit. Results indicated that explanatory talk did not predict children's causal thinking in the challenge questions. Children's exploration at the exhibit predicted both nonverbal, $\beta = .27$ ($B = .03$), $p = .008$, and verbal, $\beta = .46$ ($B = .11$), $p < .001$, outcome measures. Ongoing coding and subsequent analysis will examine whether parent-child interaction style may relate to these patterns of explaining, exploring, and causal thinking.

4-G-148

The quality of mother-child interactions differentially mediates the relationship between maternal depression at 15 months and later language outcomes for boys and girls

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Maternal depression during a child's early life relates to poorer child language development, potentially as a result of differences in mother-child interactions (Sohr-Preston, & Scaramella, 2006). However, maternal depression differentially impacts girls and boys (Murray, 1992). Here, we examine whether child gender influences the relations between maternal depression, interaction quality, and child language. We address two questions: 1) Does maternal depression at 15 months (measured by Center for Epidemiological Studies Depression; Radloff, 1977) relate to expressive language at 3 years (measured by the Reynell Developmental Language Scales; Reynell, 1991) through the quality of mother-child interactions (measured by fluency and connectedness; Adamson et al., 2016) at 2 years? and 2) Do these relations differ by child gender? Data was drawn from the NICHD Study of Early Child Care and Youth Development ($n=179$, 90 female). A moderated mediation analysis (Fig. 1) showed that there was a significant indirect effect of maternal depression on child language through quality of interaction for boys ($b = -.13$, $SE = .07$, $CI = -.28, -.02$), but not for girls ($b = -.06$, $SE = .06$, $CI = -.18, .08$). These findings highlight the importance of considering the multitude of factors that shape child language outcomes.

4-G-149

Hands on or hands off? Use of actions and gestures by Native- and Non-Native American parent-child dyads during forest diorama play

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There is considerable variation in parent-child communication across cultures. Here we examine the role of non-verbal communication (gestures, actions) produced by parents and their 4-year-old children while playing with a forest diorama. We focused on 20 parent-child dyads from each of two communities: Native Americans (Menominee) and non-Native Americans (primarily white). Children in both communities were twice as likely to accompany their speech with non-verbals than to produce speech alone (69% of utterances vs. 31%). In contrast, parents were less likely than children to produce speech with non-verbals, however, this differed across communities (M Native = 46%, M non-Native = 37%, $p < .05$). Moreover, in both communities, children were more likely to act upon objects directly (86%) than to gesture (74%), $p < .01$; whereas parents were more likely to produce gestures (25%) than actions (14%) $p < .01$. This work begins to specify developmental and cross-cultural differences and convergences in the communicative power of nonverbal exchanges.

4-G-150 Examining cognitive reflection and executive function in Colombian preschool-aged children and their parents

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Previous research has examined how analytic reasoning is related to a variety of other cognitive abilities such as scientific reasoning and executive function in adults (Pennycook et al., 2015). Yet little research has examined when analytic reasoning develops in diverse samples or in early childhood. Colombian 4- to 6-year-old children (M-age = 5.41, SD-age = .83; 49.2% Female) and parents (M-age = 30.97, SD-age = 7.12; 84.6% Female; N-dyads = 68) completed a child-modified Cognitive Reflection Test (Young et al., 2018; 6-items) to measure individuals' intuitive/incorrect vs. analytic/correct reasoning (e.g., What do cows drink? Milk or water?). Children additionally completed a Flanker task to measure executive function (EF). Regression analyses showed child age predicted child CRT and explained 10.5% of the variance; adding in child EF explained an additional 6.9% of the variance. Parents gave more analytic responses (M = 3.06, SD = 1.32) than children (M = 1.05, SD = .94). However, parent responses were not related to their child's. There was also no significant difference in the average amount of time either group (children and parents) took to provide analytic or intuitive responses. Overall, this suggests inhibition is related to analytic reasoning in early childhood, above and beyond age. But given the low average CRT score for children, analytic reasoning is likely still developing during early childhood.

4-G-151 Timing matters: How mindsets messages can promote STEM engagement in a museum setting

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This project examines how the timing of experiences during caregiver-child interaction at a museum exhibit affect children's learning and engagement. We hypothesized that messages that promote playful interaction require both children and caregivers to understand the affordances of play. We introduced sixty-four 4-7-year-olds and a caregiver to a circuit block exhibit. Each block was labeled with a message to read. Four blocks were initially placed on the table. In one condition, messages on these blocks were

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descriptive (e.g., "These are batteries"). In the other condition, the messages were mindset-oriented (e.g., "There is no wrong way to play"). After 90 seconds, four more blocks were placed on the table with the other set of messages. After playing, children were asked whether they wanted to participate in progressively more difficult challenges involving the circuit blocks. We coded how many challenges children participated in and the proportion of challenges they solved on their own. Children who received descriptive messages first engaged in more challenges, Wald $\chi^2(1) = 8.50$, $p = .005$. This effect interacted with age, Wald $\chi^2(1) = 9.29$, $p = .002$. It was stronger as children got older (and presumably were more able to read the messages). The proportion of challenges children solved was unrelated to condition. These data suggest that receiving mindset information affects children's engagement only after children have learned basic affordances with the activity.

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