HARVARD LAB FOR DEVELOPMENTAL STUDIES

Newsletter 2024

Can Children Use Rhythm to Predict When a Word Is Likely to Occur?

Jasenia Hartman (Postdoctoral Researcher); Elika Bergelson (Principal Investigator)

In this study, we ask whether babies can use rhythm and intonation to predict when a final word can occur. Children know the rhythmic, melodic, and intonational properties of their language from a very young age. For example, infants as young as 6 months can tell the difference between two languages based on rhythm. They also prefer to listen to speech that contains higher and exaggerated pitch. Research shows that 18-month-olds recognize familiar nouns faster when the noun occurs in a sentence (e.g., "Look at the hand") than when it is said alone (e.g., "hand"). One possible explanation for this result is that they can use the rhythm and intonation of the sentence to anticipate when the familiar noun will occur. However, we don't know the earliest age in which babies can take advantage of the intonational/rhythmic properties of a sentence to help them understand the final word.

To answer these questions, we have your child complete two eye-tracking experiments. In the first experiment, we put two pictures of a screen while your child is listening to sentences. During some trials, they hear normal sentences that keep the words and rhythm intact. In other trials, they hear bizarre sentences in which either the rhythm/intonation is preserved while the words are discarded (e.g., similar to karaoke where you hear the rhythm and melody of the song but not the artist singing) or the words are preserved while the rhythm/intonation is flattened (e.g., similar to hearing a monotone "robot" voice). As they watch and listen, we are tracking their eye movements. We can calculate how quickly they look at the target image across the three conditions. In the second experiment, we show them two pictures of common objects while playing sentences containing one of the words as a way to measure which words they know. We have just finished piloting the study and will begin data collection soon!

Children's Understanding of Mental State Reasoning Within Close Relationships

Brandon Woo (Former Postdoctoral Researcher); Emma Yu (Lab Manager); Megan Richardson (Research Assistant); Haowei Peng (Research Assistant); Andrea Ventura (Research Assistant); Ashley Thomas (Principal Investigator)

Imagine being on a roller coaster. Are you more scared or excited? Now ask: Who in your life might be best able to predict your emotional state: your best friend, your coworker, etc.? In the present study, we asked whether 4- to 9-year-old children understand that people within close relationships may be more accurate at representing each other's minds. We have found evidence that by around 5 or 6 years of age, children think that close friends will know about each other's minds. We have written up the findings in 7- to 9-year-olds as a proceedings paper for a conference: https://osf.io/preprints/psyarxiv/cqz26.

After we had gotten these findings in older children, we tried asking whether toddlers also might think that close friends are more likely to know about each other's minds. Specifically, 12- to 15-month-old toddlers saw one character repeatedly touch a red circle protagonist, while another character did not engage in such touching behavior. Later, the red circle moved to one toy (e.g., a car) over another (e.g., a ball), as though it had a preference. Would toddlers expect the character who'd touched the red circle to be more likely to know of the red circle's preference? Although data from a small pilot sample were promising, we ultimately did not find evidence in a larger sample that toddlers expected the character who'd touched the red circle to know of the red circle's preference.

Preschool Story Time: How do Toddlers Understand Words in Stories?

Briony Waite (Graduate Student); Tanya Levari (Postdoctoral Researcher); Anthony Yacovone (Postdoctoral Affiliate); Jesse Snedeker (Principal Investigator)

In this study, we want to study how young children understand the words that they hear, especially while they are listening to stories. We recorded your child's brain activity by placing electrode wires on their scalp. Then, they listened to stories while wearing the cap and wires. We recorded their brain activity to all the words in the stories. Some of the words in the story are words that kids hear more often in their daily lives, like "***tree***," and others are words that we don't hear as much, like "***sailor***." And some of the words are more predictable in the context, like "I see a bird flying in the ***sky***" and others are less expected, like "Today I have a sandwich, carrots, and ***strawberries***." We are interested in looking at a particular brain wave that is related to how easy or hard it is to understand a word. We know that in adults, this brain wave is larger when we hear single words that are less frequent than when we hear single words that are more frequent (***sailor*** vs. ***tree***) and is also larger when we hear words in a story or sentence that are less predictable than when words are more predictable (***strawberries*** vs. ***sky***). We want to know whether we also find this pattern in toddlers!

Data collection is still in early stages for this study, so please check back next year! Thank you for joining us for story time, and we hope to see you again soon!

Abstraction for Babies

Elena Luchkina (Research Scientist); Elizabeth Spelke (Principal Investigator)

Infants can distinguish small quantities (e.g., 2 vs 3) and recognize relational structures (e.g., same and different) in the first year of life. Yet, they struggle with number words ("two", "three") and relational terms ("same", "different") until about age 3. Why do they take so long to learn the meanings of these words? One possibility is that children cannot map abstract ideas onto words until age 3. Another possibility is that natural language environments provide sparse data for infants to make inferences about those words' meanings. For example, "two" can be used in reference to two people, two ideas, two days, two actions, etc., which makes it hard to infer the meaning of the word “two”. In contrast, the word “ball” is reliably used in reference to a round object. As a result, it may take longer for infants to accumulate enough observations to learn those meanings. An experimental investigation is needed to distinguish between these two alternative possibilities.

What Does it Take to Learn a Few New Words?

Kristen Gilyard (Graduate Student); Elika Bergelson (Principal Investigator)

With this study, we are interested in understanding what helps toddlers learn new words. We know that young toddlers already know a lot of common words. However, it is hard to know exactly how many times they need to experience the word before they can learn it. For example, how many times does a toddler have to experience an apple before they learn the word “apple?" 5? 50? 100? We also know that during the 2nd year of life, toddlers are improving in their word learning every day. That means 14-month-olds might need *more* experiences with new words to learn them than 22-month-olds, who have gained more overall word knowledge and other developmental skills, even though they are relatively close to each other in age.

To find out if that’s true, in this study, we introduce 3 new words into the toddlers’ environments with a picture book! We hope to better understand the differences in comprehension across 14- ,18-, and 22-month-olds.

Caregivers read the picture book twice a day for 2 weeks and record these shared book-reading sessions. In the recordings, caregivers of older toddlers (the 22-month-olds) tend to read for longer and go beyond the text of the book to add extra words or sentences. These extensions beyond the book included comments bringing attention to the new object's color (“This one is yellow”) or connections to the toddlers’ experiences (“That looks like your PJs”). From our results so far, it seems like the more extensions a parent includes during reading, the more likely their toddler is to produce these new words.

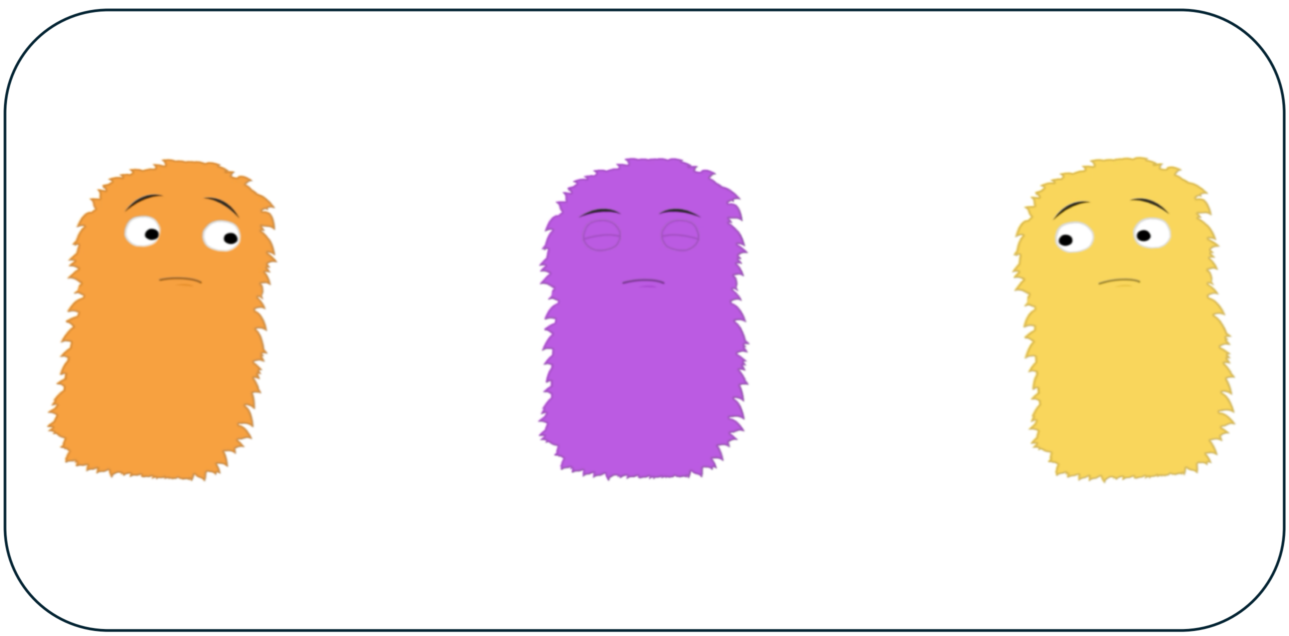
After 2 weeks, caregivers and toddlers return to the lab for an eyetracking study and a short activity! These tasks both allow us to measure how well the toddlers comprehend the new words. In the eyetracking study, we show 2 images to the toddlers and play a voiceover that prompts them to look at one of the images. We then look to see where the toddlers look the most. With the activity, we have brought the objects from the book into the real world! We present a set of felt objects to the toddlers on a tray and ask them “Where is the ___?” The toddlers then help us place the object in a bucket. We have just started this new activity and are excited to see where it goes. There are a lot of competing factors that influence toddlers' choices, such as a side preference or a color preference.

With about 40 toddlers, we see 1) some overall word comprehension of the new words (the picture book introduced them enough times!) and 2) some age differences where the 22-month-olds are looking faster and more at the prompted object than the younger toddlers are. Our target is 144 toddlers in total, so we still have a way to go!

Do Babies Use Accent to Predict Who Will Respond to Distress?

Denisse López (Lab Manager); Christina Steele (Graduate Student); Ashley Thomas (Principal Investigator)

In this study, we want to understand if babies have expectations about people who share an accent. Specifically, we are interested in whether babies expect characters to comfort each other if they have the same accent. Participants are toddlers between 13 and 18 months and 30 days of age from the United States who are exposed to English at least 80% of the time. For more information about the methodology of this project, please read the following pre-registration on the Open Science Framework (OSF): https://osf.io/m647k



Early Understanding of Commutativity in Preschoolers

Marie Amalric (Postdoctoral Researcher); Nick Kendall (Research Assistant)

Commutativity – the property of an operation that allows one to change the order of the operands without changing the results – is a fundamental principle of mathematics. Young children seem to have early intuitions that addition is a commutative operation, even before knowing formal additions. On the contrary, evidence for early intuitive grasping of the commutativity of multiplication is much less clear. In fact, the commutative principle in additive contexts is intrinsically one-dimensional while it is intrinsically two-dimensional in multiplication, and interpreting multiplication as repeated addition may render perceiving its commutative principle difficult.

Here, we investigate the existence of precursors of the understanding of the commutative principle of multiplication in preschoolers, i.e., before learning symbolic multiplication, and the type of representations that preferentially support them. To do so, 5-year-old children are asked to decide whether two characters got a fair or an unfair share of apples at a tree. The apples that each character got are displayed on each side of the screen. They probe commutative multiplication and addition versus identity (ungrouped arrays) and test the influence of simple grouping, geometrical cues such as rectangular display and 90° rotation, or language on the perception of equal commutative quantities.

Our results so far confirm that additive commutativity is more easily perceived than multiplicative commutativity. With simple grouping, 5-year-old children answer at chance in both multiplicative and ungrouped cases. When added to the layout of the groups of apples, geometric cues strongly improve children performance. However, adding linguistic descriptions of the situations did not help children's number perception. Our results may suggest that with simple grouping, the intrinsic symmetry of commutativity is lost, while a rectangular array that is rotated from horizontal to vertical directions provides a geometrical description of the commutative principle. This has implications to teaching the commutative principle of multiplication at school.

How do Children Order Temporally Ambiguous Events and States?

Elena Marx (Visiting Graduate Student); Chinasa Ohajekwe (Research Assistant); Hanna-Sophia Shine (Lab Manager); Eva Wittenberg (Co-Principal Investigator); Jesse Snedeker (Co-Principal Investigator)

In a sentence like "*The girl **fed** the rabbit that **hopped** to the fence"*, what happened first? Did the girl feed the rabbit before or after it hopped to the fence? Given that linguistic descriptions often lack explicit information about the sequential order between situations, the question is: what factors determine how complex temporal structures are mapped onto linguistic form?

This study examines how children comprehend the temporal order of ambiguous events. While prior work has focused on the influence of pragmatics (i.e., the influence of context on the interpretation/understanding of language) and syntax (i.e., the influence of sentence structure on the interpretation/understanding of language) on the comprehension of temporal order, the current study is exploring the influence of event cognition. Specifically, how do perceptions of temporal order shift when presented with events and states?

Previous research on language comprehension has shown that adults have a strong tendency to temporally order states before events. In this experiment, we ask how this tendency takes shape during development. This study will help us understand how event structure and linguistic structure map onto each other; and it can help us link research on event construal more broadly to linguistic and cognitive development. Data collection has just begun, but we are excited to share findings from this study in the future!

Find Sound: A Game-Based Intervention to Improve Children's Reading Skills

Gianna Zades (Research Assistant); Akshita Srinivasan (Graduate Student); Cristina Sarmiento (Lab Manager), Ayana Lomas (Research Assistant); Isminur Yilar (Research Assistant); Elizabeth Spelke (Principal Investigator)

Reading is an essential skill that helps children grow intellectually and better understand the world around them as they learn to decipher both sound and meaning in written language from a young age. Reading broadens a child's horizons, as readers of both fiction and factual texts discover and explore physical, cultural, and social worlds beyond their immediate experience. Learning to read is a process that formally starts in kindergarten and continues through early elementary school. Previous research has shown that early reading skill is a predictor of children's success in the rest of their education. In order to help support children's reading acquisition at home, we developed a fun game that focuses on teaching the different sound properties of words including rhyme, alliteration, and syllables. We ran our study initially in 2022-2023 and have revised it to a slightly modified version where we tested children in kindergarten, not just the age in kindergarten.

Our study tested the effectiveness of this reading game by comparing it to a similar game in the domain of geometry. We evaluated the extent to which these games improved kindergarten (5-6.5 years) children's school-relevant reading and geometry skills in the short term. The geometry game, “Find Shape,” and the reading game, “Find Sound,” are played as a game of war, where children are asked to find which shape or word belongs in a group based on its geometric or sound properties. Each participant was sent one of the games to their home. The study involved two remote zoom sessions that were about 45-60 minutes long and at-home gameplay for about 2-3 weeks in between the two sessions. In the first session, we asked children questions on the computer about reading and geometry and then another researcher taught the child and parent how to play the game. Then, parents were asked to engage in at-home gameplay with their child on 8 separate occasions. Finally, in the second zoom session the child and parent played one more round of the game and then a researcher asked the child more questions related to geometry and reading. Previous preliminary results indicated that children who played Find Sound did not show significant improvements in their reading scores compared to children who played Find Shape, though the results were trending in the direction that favored children who played Find Sound. The previous preliminary data also indicated that, in comparison to those who played Find Sound, children who played Find Shape showed significant improvements in one set of geometry skills that were directly trained in the game and tested in the assessments. We are still in the process of analyzing the data from this last round of testing. We also received qualitative data from participating children and their families regarding the duration and difficulty of the games in addition to their feedback on how the games might be adapted and improved based on their experiences playing them at home. This research evaluated the effectiveness of two home-based educational interventions with the aim of improving children's school relevant skills in the short term and the hope of fostering their subsequent learning in school.

The outcomes of this work are extremely useful as we continue to develop and test educational interventions that can support the success of young children. Figure 1: Find Sound is played with two players. Each player has their own deck. For each card, the child must find the answer on the bottom (blue, red, or green) that matches the symbol or word represented by an image on top. Once the players have determined the correct answer, the player whose card has borders that are the same color of the correct answer gets to keep both player’s cards in their ‘winning pile.’ After repeating for each card in a deck, the player with the most cards in their winning pile wins.

Early Understanding of Parent-Child and Other Caregiving Relationships

Christina Steele (Graduate Student); Denis Tatone (Postdoctoral Researcher); Ashley Thomas (Principal Investigator)

Every day, we recognize social relationships and use knowledge about social relationships to inform our behavior. We act to maintain our existing relationships, create new ones, and change the ones we have. For example, we recognize that it is acceptable to eat off our spouse's plate, but unacceptable to eat off our employer's plate. We may laugh at our boss's joke to maintain our deferential relationship or do a favor for a coworker to maintain a cooperative one. We might bring a rose to a friend to create a new intimate relationship or advocate to incorporate voting to change our book club into a democracy. While scholars in Anthropology, Sociology, and related fields have long studied the structure and nature of social relationships, relatively little is known about how these behaviors arise from cognitive processes in individual minds, especially in babies and young children. Babies are born into complex social networks made up of many relationships. The most relevant and common relationships in a baby's social network are caregiving relationships. These can be with parents, older siblings, teachers, grandparents, babysitters, nannies, etc. Even when a baby's social network expands, caregiving relationships dominate the social experience of young humans throughout early childhood. Compared to most other species, human babies are more dependent and interact with a greater number of caregivers. Accordingly, the ability to recognize caregiving relationships may be particularly useful for humans.

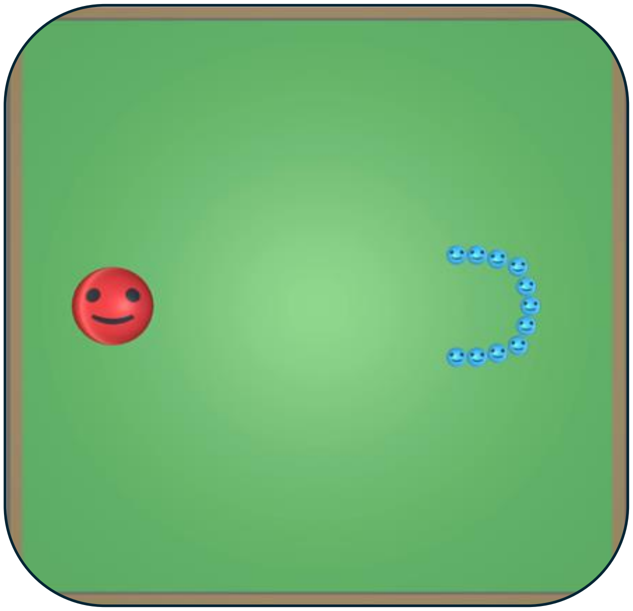
We are currently running a study to investigate how and whether babies represent caregiving relationships, specifically testing whether they use physical (e.g., size) and social cues (e.g., touch) to make predictions about response to distress and food requests. So far, we have found that babies appear to expect characters who are bigger and have a close relationship with a smaller character to comfort the smaller character when it is in distress. This tells us that babies may have early abilities to recognize social relationships (e.g., caregiving) important for their survival.

"Some" and "All" in Infancy

Irene Canudas Grabolosa (Postdoctoral Researcher); Dhiya Sani (Research Assistant); Gennaro Chierchia (Co-Principal Investigator); Susan Carey (Co-Principal Investigator)

The aim of our study was to investigate whether young children can understand logical concepts before they can verbally express them. Specifically, we sought to determine if they could differentiate between the concepts of "some" and "all."

To achieve this goal, we recruited 25 participants aged 11-13 months, 15 participants aged 18-20 months, and 15 participants who were 3 years old. Using an eye-tracking machine to record where and for how long they looked, we showed them a series of videos where a large ball collided with a group of small balls, causing some of the small balls to explode. We continued to show these videos until the children lost interest. Then, we presented a new video where all the small balls exploded, instead of just some of them. If the child could differentiate between "some" and "all," they would find the new video more interesting and show renewed attention.



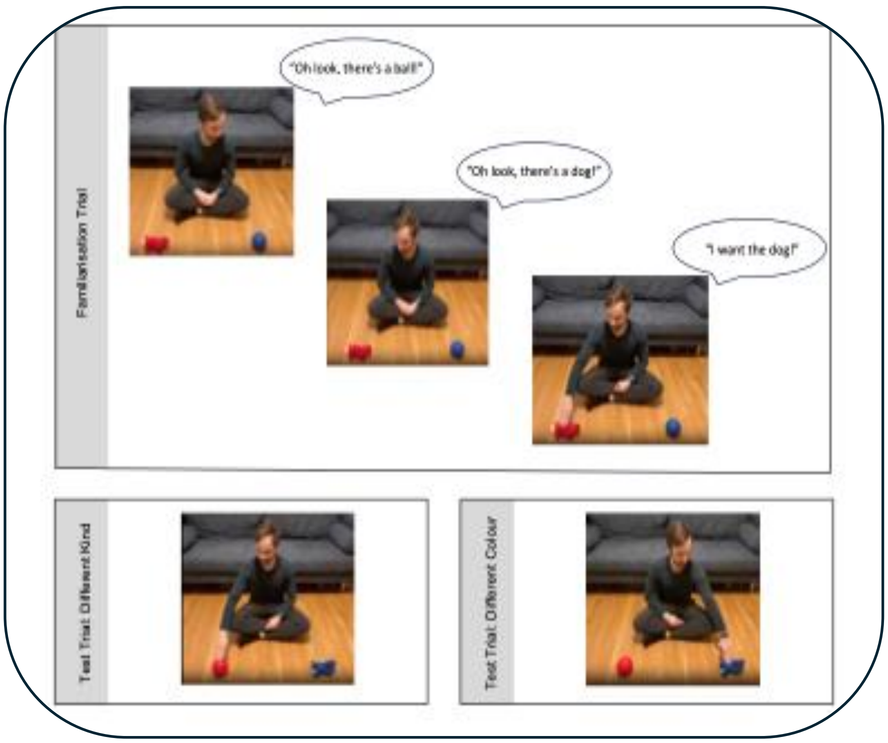
Our results indicate that children looked slightly longer at the “all” videos than at the “some” videos, with their pupils also reacting differently, which could suggest they can differentiate between these concepts. To strengthen this conclusion and ensure they are not reacting to other dimensions of the videos, we are currently running a version where we show them videos with all the balls exploding first, and then test them with videos where only some of the balls explode. Stay tuned for the results!

Can 14–16-month-old Toddlers use Language to Understand Other’s Actions?

Ayana Lomas (Research Assistant); Helena Goldbaum (Research Assistant); Brandon Woo (Former Postdoctoral Researcher); Elizabeth Spelke (Principal Investigator)

The ability to understand actions as goal-directed forms the foundation for understanding others’ intentions, beliefs and thus mental states. From an early age, infants recognize that actions can be goal-directed and motivated by the desire to achieve a specific outcome. However, in real-life contexts, there may be multiple goals underlying one action, and this ambiguity can make it difficult to discern the motivation underlying one’s actions. Adults with a mature level of action understanding can use context cues, such as other's speech to overcome this ambiguity. However, we do not know when this mature action understanding or when the ability to use language to understand other's actions emerges.

By 14 months of age, toddlers begin to better comprehend aspects of others speech and can use grammatical forms such as nouns and adjectives to reason about situations involving objects. Therefore, we investigated whether toddlers utilized this sensitivity to goal-directed actions and grammatical forms to understand other's actions.



In this study, we showed 14–16-month-old toddlers videos of a person sitting in front of two different kinds of objects (such as a red dog and blue ball), labelling what he sees using either their object kind or color label, and then expressing desire for one object. The objects in front of the actor then change (e.g., from a red dog and blue ball to a blue dog and red ball). We examined whether toddlers looked longer when the person then reached for the object opposite to what would be expected based on his previous speech. Our results suggest that toddlers at this age may not yet use language to infer the actor's desired object, indicating that by 14-16 months, toddlers might not be able to fully utilize language to understand others' actions.

Does Understanding Other People's Pointing Unlock Word Learning for Young Babies?

Grace Benkelman (Research Assistant); Lilli Righter (Lab Manager); Elika Bergelson (Principal Investigator)

We see that children undergo a "word comprehension boost" around 12 to 14 months old, on average. We want to know what other skills kids might need to develop to hit this word boost. Past research has found that there is a relationship between young babies' ability to understand adults' pointing and their later vocabulary. We are investigating how strong that relationship is and if learning what someone's trying to tell you when they point at something is also the main skill that helps you figure out words faster.

In this study, we play three games and also do an eyetracking study. In one super quick game, we point towards fun stuffed animals around our room and just see if the baby will look towards the animal we're pointing at. Almost all babies in this age range do this, easy peasy! Then it gets a little harder: we play a game where we need babies to guess something about what we're trying to tell them with a point. We have two boxes, covered with curtains. We show the baby a really cool toy we want to play with, and then, putting our hands under the table, we hide the toy in one of the boxes! We ask the baby to find the toy and we point to the box where it is hidden. If a baby is able to understand points, they will pull the curtain off the box we're pointing towards and find the hidden toy, and get to play with it.

The last game and our eyetracking study are two ways that we measure if a child has reached the word comprehension boost. In our game, we're trying to fill up a gift bag for our friends. We have a set of soft felt objects that look like common things: a bottle of milk, a car, a sock, a stroller, a banana, and a baby. We put two objects at a time on a tray and ask the baby, "Pick up the banana!" We have them put whatever shape they pick up into the bag. The eyetracking study is very similar, but instead of felt shapes they have to pick up, we put two pictures on the screen and see where they spend the most time looking. The felt game is a new method that we are trying out as a new way to assess word learning. We aren't sure if it clearly tells us about babies' word knowledge– we think we are seeing some effects of kids being right- or left-handed, and being more drawn to play with some objects than others, even if they know all the words.

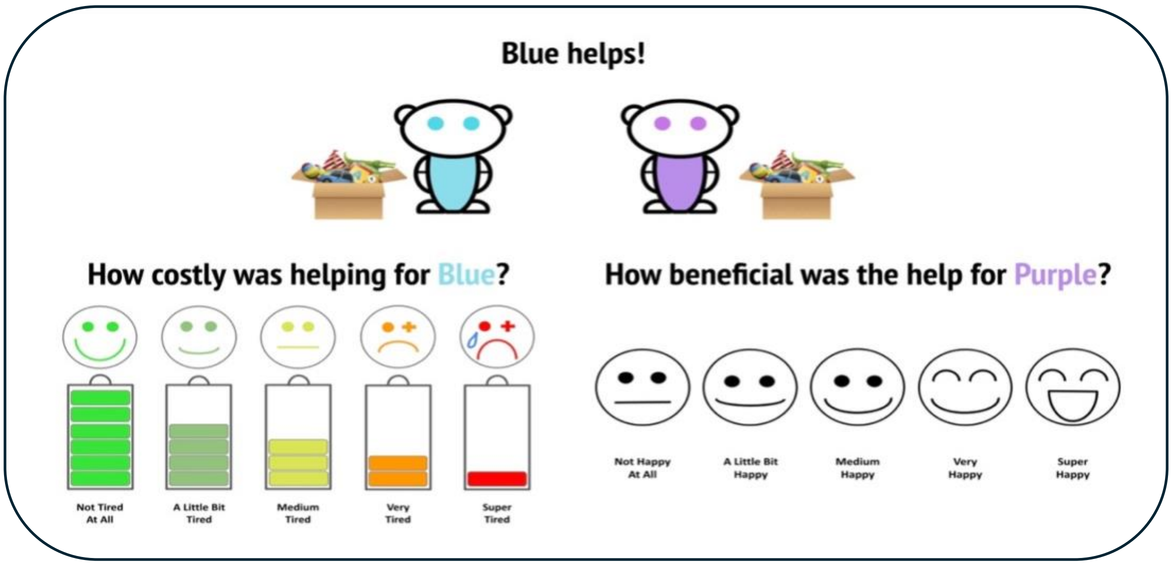
We have a small pilot sample for this study, and we see that kids get better at point comprehension right around 12 months old, which is promising! We also see that kids who know more words tend to be better at point comprehension, but we won't know until we have our full sample whether point comprehension independently contributes to the word boost, since we see that both word knowledge and point comprehension improve as kids get older.

How Do Kids Think About Helping Across Different Relationships?

Emma Yu (Lab Manager); Kana Tsuruta (Summer Intern); Ashley Thomas (Principal Investigator)

We are interested in whether 6- to 8-year-old children think about the cost and benefit of helping across different relationships. While prior research has investigated children's intuitions about helping in different relationships, less is known about how they perceive the costs and benefits.

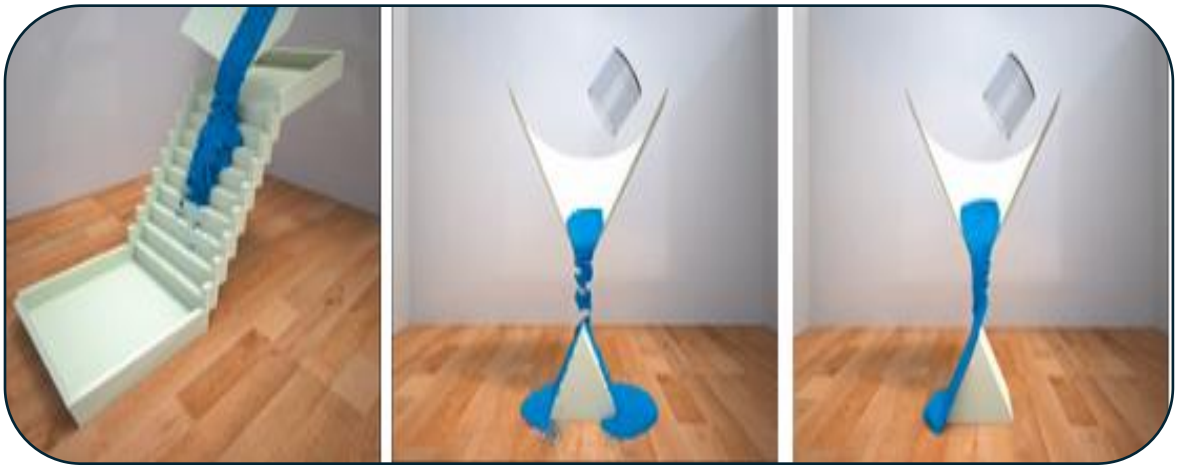
We showed children different stories about characters helping others of varying relationship closeness (strangers, classmates, siblings, or best friends). We then asked questions about how costly it was for the character who helped (how tired the helper felt) and how beneficial it was for the character who was helped (how happy the recipient of help felt).



Data collection has just begun, but we are excited to share findings from this study in the future!

How Do Babies Understand Sand?

Sanghee Song (Visiting Postgraduate Research Fellow); Vivian Paulun (Postdoctoral Researcher); Elizabeth Spelke (Principal Investigator)



Researchers have found that babies often find it harder to understand non-solid objects like jelly, sand, or water compared to solid ones like boxes or balls. However, in everyday life, babies see both types of objects all the time: they see formula in a bottle, water splashing in the tub with a rubber duck, and an older sibling enjoying Jello or pudding.

Our recent study aimed to understand how babies as young as 5 months old perceive non-solid objects when they interact with solid ones like glass, stairs, or floors. We conducted a 10-minute online study with 16 infants aged 5 to 11 months. The babies watched different materials (sand within a box) being shaken in a glass and then poured onto various settings, as shown in the image,

To understand what the babies were thinking, we measured how long they looked at different events. Babies tend to look longer at things they find surprising or unusual. By measuring how long they watched, we could tell what they expected to happen and what they didn't. Although we were able to have babies' attention until the test event, babies seemed to get bored at the test event due to the long duration of the event. We decided to reduce the duration of the test even to better capture babies' attention. Stay tuned for more updates as we continue to explore the amazing cognitive abilities of infants and how they make sense of the world!

How Children Navigate Disagreements in Different Group Dynamics

Mack Briscoe (Graduate Student); Ashley Thomas (Principal Investigator)

Social groups are a part of our daily lives. They might appear as a collection of close friends, work colleagues or acquaintances. And these different groups can also be structured in various ways. At work, perhaps your team is quite hierarchical and centered around your boss. In your friend group, maybe everyone seems to stand on an even playing field. How do these structures affect the ways people think about decision making and disagreement?

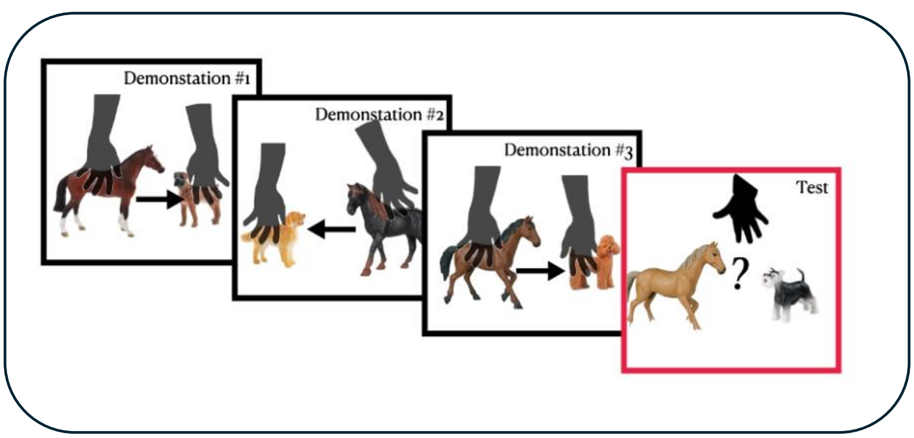
To test this question, we presented 6-8 year olds with two novel groups: one which is hierarchical (i.e., it has a boss who decides everything) and another which is egalitarian (i.e., everyone makes decisions together). After children see a couple of interactions, they are informed that someone in each group dislikes the current decision being made. We then ask children whether they think that person will talk to their group, just deal with it, or leave their group to join another that is already doing what they want to do.

We've only just finished piloting and plan to start data collection soon! We look forward to sharing the results then.

Fun on the Farm! Children's Understanding of Event Participants

Irene Canudas Grabolosa (Postdoctoral Researcher); Eleni Livingston (Research Assistant); Jesse Snedeker (Principal Investigator)

In this study, we are exploring how children and infants understand events and how broadly they think about the participants in these events. When encountering different scenarios, such as various horses pushing different dogs, do children form the general idea that "horses push dogs," or do they perceive each instance of a horse pushing a dog as a separate, unrelated event?



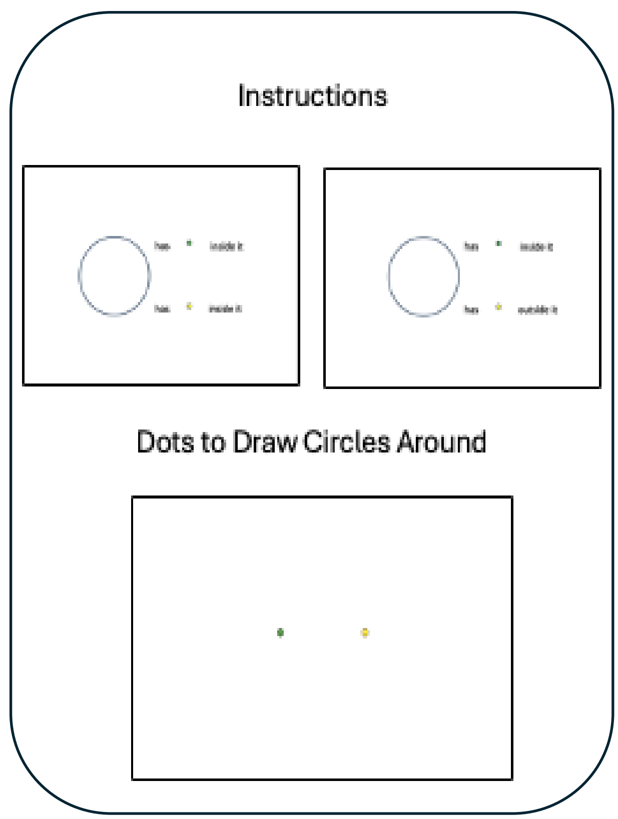
Past research suggests that forming such general concepts requires substantial language experience. Without it, one might only see each scenario as isolated events. To investigate this hypothesis, we tested 15 five-year-olds using an imitation task. In this task, we showed them three different examples of one animal acting on another species (e.g., three different horses pushing three different dogs). Then, we presented them with a fourth exemplar of each species (a fourth dog and a fourth horse) and asked them to imitate what they saw.

The results showed that five-year-olds excelled at this task, consistently generalizing by having the fourth horse push the fourth dog. This suggests that the role of language experience in forming these general thoughts is smaller than previously hypothesized. However, since five-year-olds already have some language experience, we are now starting to test 18-month-old infants on the same task to further investigate the importance of language. Stay tuned for more results!

How do Children use Deductive Reasoning to Make Geometric Inferences?

Olivia Pownall (Research Assistant); Yujia Liu (Research Assistant); Elizabeth Spelke (Co-Principal Investigator); Marie Amalric (Co-Principal Investigator)

Research suggests that both adults and children use the interactions between objects, called topological relations, to make sense of new spatial information. For example, if you were told that there was a man to the left of a car, and the car was to the left of a truck, you could use deductive reasoning to infer that the man is to the left of the truck. This can also apply in the field of geometry, as topological relations can help us infer the positions of shapes like circles and dots. In previous adult studies, a bias in this deductive reasoning emerged: adults tend to rely on moving objects (translation) rather than resizing them (scaling) when making geometric inferences. Adults performed significantly worse in problems where they had to change the size of objects to find an alternative topological relation. This bias is called the ‘Locking Property’.



This study aims to assess if children also show this bias. Do they rely on moving objects instead of resizing them to understand geometric relations? By simplifying this task for children, we hope to help uncover whether this tendency is something they learn over time or if it is an intuitive part of their geometric reasoning. To do this, 8-10-year-old children were asked to draw circles based on instructions around two dots. Some of these questions had the 'Locking Property'. After, we asked if they could find a different topological relation (drawing) that still met the given instructions, helping us understand how they reason about space and shapes. Pilot results suggest that children are performing similarly to adults in these scenarios, but we are currently in the process of formal data analysis to make a definitive conclusion.

Is Knowing the Sound Structure of Words the Secret Key to the Word Comprehension Boost?

Lilli Righter (Lab Manager); Elika Bergelson (Principal Investigator)

Babies start recognizing words as young as 6 months old, but they get exponentially better at learning and recognizing them between 12- and 14-month-olds. We want to know what contributes to this "word boost," and whether there's a single most important skill babies have to develop for words to take off. Some of the things that scientists have argued that drive word learning that change around this time include motor skills, social skills, planning and processing skills, but also specialized language skills. One of those language skills is recognizing what sequences of sounds are real, familiar words in the language you're learning (diaper, ball, shoe) and what isn't a common word (depper, bool, showe).

This study asks whether recognizing familiar wordforms is strongly related to the word comprehension boost. English-learning babies who participated in this study did two video activities. In the first part, parents and baby sit in our sound-proof booth and watch a video that appears on three screens: one in front, one on the left, and one on the right. We play alternating sequences of words while a flashing bullseye plays on the right or left screen: either a series of real English words, or a series of made-up words that have the right sound structure of English, but that kids wouldn't have heard before! We measure how long babies spend turning their head to look at the screen and use that as a measure of how long they're interested in each list of words. If they spend different amounts of time listening to the real and fake words, that tells us they are distinguishing them! This gives us an idea if a child is actively recognizing familiar wordforms.

For the second part, the child participated in an eyetracking study. For this study, we put two pictures of common child-oriented objects (books, bottles, etc.) on the screen at a time, and we just ask "Where's the book?" How long babies spend looking at the right picture, and how quickly they look, can give us an idea of how easy word comprehension is for them. By doing both parts of the study at the same time, we can tell if wordform recognition always comes before the comprehension boost.

We only have a few participants in this study so far– look out for more results next year!

What Babies Learn from Their Caregivers

Brandon Woo (Former Postdoctoral Researcher); Haowei Peng (Research Assistant); Andrea Ventura (Research Assistant); Ashley Thomas, (Principal Investigator)

Past research has examined what babies understand of other people's actions but has mostly presented babies with people who are strangers. Yet, the people whose minds may be most relevant for learning, cooperation, and social life are the people within a child's social network: especially the child's own caregiver. The present study asks whether 9-month-old babies may be more sensitive to the goals of their caregivers vs. strangers. We have some promising pilot evidence, and we're now running a larger study to determine whether this effect might be real.

Does Feedback Affect Girls' and Boys' Interest in Math or Reading?

Sam Gregory (Research Assistant); Sara Valencia Botto (Postdoctoral Researcher); Elizabeth Spelke (Primary Investigator)

Achievement in math is crucial to success at school and the pursuit of many STEM careers. However, from the early years of schooling, girls underperform in math relative to boys. A recent study reported that this gender gap does not exist in kindergarten, before formal mathematical instruction is given. This finding raises a critical question: might gender differences in the feedback teachers offer shape girls' and boys' subsequent motivation to learn math? We know that children's behavior is greatly affected by the feedback and evaluations of adults. For example, 3-5-year-old children who are praised for being smart are more likely to cheat, presumably to uphold a reputation for being smart. More recent studies indicate that 3-5-year-old children will strategically engage in one activity over another to obtain a positive evaluation from an adult. Importantly, research indicates that the effect of praise and feedback vary by gender. For example, person praise (e.g., "you're really good at this!") diminishes girls' motivation to pursue a challenging task but has little impact on boys.

This study investigates whether positive feedback regarding performance in reading or math activities influences 5- and 7- year-olds' subsequent performance and decisions to pursue either 'easy' or 'hard' activities in these two domains. Using a behavioral experiment, children will complete a timed activity in both reading and math before receiving positive feedback on only one of these domains. To see the *potential* effect of this feedback, children will be asked to choose an 'easy' or 'hard' activity in reading and math.

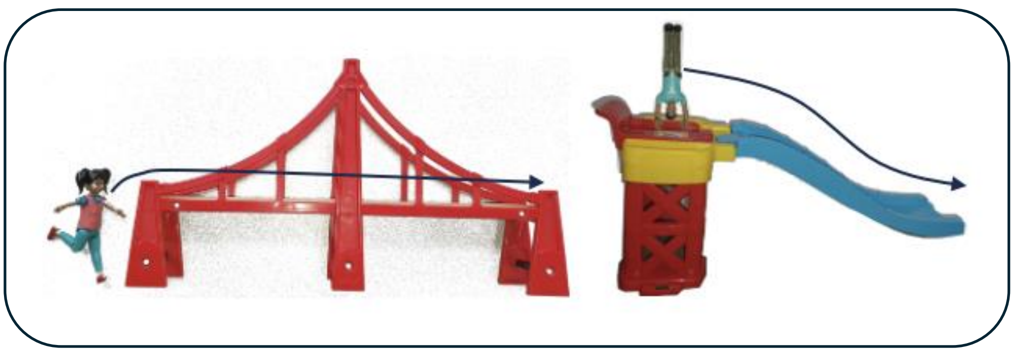
Similar to previous findings, preliminary data with 15 participants indicate that 7-year-old boys perform better than girls in math, but 5-year-olds show no gender differences in math. In reading, gender differences were not found in either age group. Importantly, there is a trend where boys are more willing to choose hard math activities, whereas girls seem to choose easy math activities. More data will be needed to examine the effect of feedback on these choices.

Funny Moves in Funny Paths: Children's Understanding of Event Dimensions

Irene Canudas Grabolosa (Postdoctoral Researcher), Hillary Jean-Gilles (Summer Intern), Jesse Snedeker (Principal Investigator)

In this study, we aim to explore how children comprehend different aspects of motion events. Specifically, we're focusing on two key dimensions: **manner** (the way in which something moves) and **path** (the trajectory it follows).

To investigate how abstractly children think about these dimensions, we designed an imitation game. In this game, 5- to 7-year-old children watch a series of figurines that either move in different ways while following the same path (keeping the path constant but varying the manner) or move in the same way while following different paths (keeping the manner constant but varying the path). After each figurine demonstrates its movements, the children are invited to imitate what they've seen.



The goal of this game is to determine if children can abstractly differentiate between manner and path. If they can, we expect them to recognize patterns—such as always keeping the path constant while varying the manner—and therefore show a preference for imitating one dimension over the other. We're just beginning to test this game, so stay tuned for exciting results!

Young Humans’ Evaluations of Antisocial Acts of Saliva Exchange

Mia Taylor (Research Assistant), Brandon Woo (Former Postdoctoral Researcher), Ashley Thomas (Principal Investigator)

Adults often socially evaluate others based on their actions, and the same actions can be construed as prosocial or antisocial depending on contextual factors such as consent. In this project we explore whether consent is salient for children in their social evaluations of actions that involve saliva sharing.

We tested this by showing participants (mean age = 6.726 years, range = 6.01 to 8.99 years) videos in which one character interacted with a central protagonist’s food in their absence and another character did so in their presence. There were three within-subjects conditions: the Saliva Condition (where both actions involved saliva sharing), the Touch Condition (both actions involved touching food), and the Prosocial Condition (both actions were prosocial). We then asked whether the action was okay, which character was nicer, and how close each character was with the central protagonist.

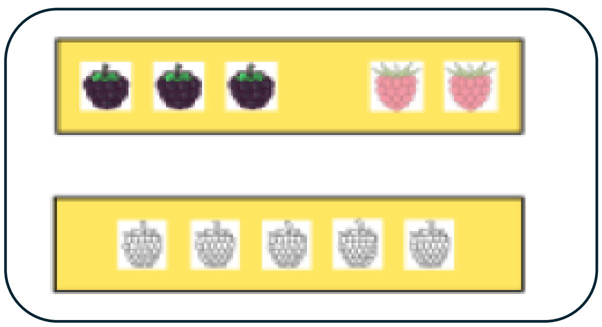
Absence/presence affected children’s evaluations of actions, as well as social closeness ratings. Children thought nonconsensual actions involving saliva sharing and touch were not okay, while absence/presence did not affect children’s evaluations of prosocial actions, which they always thought were okay. Children expected those who shared saliva or touched the same food in each other’s presence to be closer to one another than those who did not. Closeness ratings for prosocial actions were unaffected.

Can Compositional Language Help 2.5- 4-year-old Children Learn New Number Words?

Lucia Vilches (Graduate Student); Akshita Srinivasan (Former Graduate Student); Elizabeth Spelke (Principal Investigator)

Prior to formal education, children have capacities for representing small numbers exactly (e.g., the difference between “two” and “three”), and large numbers approximately (e.g., the difference between “twenty” and “forty”). However, the question of how we come to create exact representations of large numbers (e.g., the difference between “twenty” and “twenty-one”) remains open. In this study, we aim to get closer to answering this question by testing one proposal, which posits that compositional language (language that shows how large numbers are made up of smaller numbers) may allow children to create exact representations of large numbers.

For this study, we are recruiting children ages 2.5-4 years of age who are monolingual English-speakers. Each child completes a short (15-25 minute) series of activities. First, they demonstrate their number-knowledge by picking out sets of a variety of sizes (e.g., "which of these plates has exactly five pieces of candy?"). Then, they watch and interact with a demonstration in which they will be exposed to sets of either "five" or "six" objects. In this demonstration, half of the children in our sample will be shown how the set of "five" or "six" can be broken down into smaller subsets (a set of "three" and a set of "two", in the case of "five"; and a set of "three" and another set of "three", in the case of "six). The other half of the children will be shown how sets of "five" or "six" are made up of individual objects. After these demonstrations, children will interact with sets of objects of varying sizes, to show what they have learned from the demonstrations. We expect children who are shown how the larger set can be broken into smaller subsets to learn more about numbers.



Better understanding how children acquire number concepts can help us develop effective interventions to aid their learning. The implications of this research are not limited to number learning. Compositional concepts allow for flexible and generalizable learning. We hope that by using number learning as a case study, we can contribute to the broader literature on children's understanding and learning of compositional concepts.

Data collection for this project is ongoing. We are grateful to the families who have participated so far, and we look forward to sharing what we find in a future newsletter! We are excited to see what the results of this study tell us about how children learn about numbers!

What Information Do Kids Use to Identify Words in Spoken Language?

Margaret Kandel (Graduate Student); Nan Li (Postdoctoral Researcher), Jesse Snedeker (Principal Investigator)

When you listen to someone speak, there are multiple potential sources of information that you could use to help you identify the words that you are hearing. One source of information is the sounds of a word. Another source of information is the context in which the word appears. For instance, when you hear the sentence, *The baby drank the mi…* and try to identify the final word, you can rule out candidates like *mitten* that match the sounds but don't fit the meaning of the sentence. You may even be able to predict that you are going to hear the word *milk* later in the sentence when you hear the words *baby* and *drank*. In this study, we are interested in whether children, like adults, are able to use contextual information in addition to sound information as they identify upcoming words in a sentence.

We conducted this study with 4–5-year-old children and adults who spoke American English. In this study, participants were seated in front of an eye-tracker. In each trial of the experiment, they saw four pictures and heard a sentence that included the name of one of the pictures. Their job was to select the picture whose name they heard in the sentence. In each sentence, there was a critical word that appeared before the participant heard the name of the picture they would select. We manipulated how predictable this critical word was and whether there was a picture on the screen whose name started with the same sound (a cohort competitor). For example, participants may hear the critical word *bed* when there is a picture of a belt on the screen. We tested whether participants looked more at the cohort competitor image (e.g,. belt) than at an unrelated control picture (e.g., stream) as they began to hear the critical word (e.g., bed). Increased looks to the competitor would indicate that participants considered it as a potential match to the sounds they were hearing. If our participants were able to use sentence context to constrain word identification, we expect fewer looks to the cohort competitor image when the critical word was predictable than when it was not.

We found that both adult and child participants looked at the cohort competitor image more than a control picture only when the critical word was not predictable. The fact that they did not look at the competitor when the critical word was predictable suggests that they were able to use the contextual cues to rule out the competitor as a potential match to the sound input. There was no reliable difference in this effect between the 4–5-year-olds and the adults, suggesting that young children, like adults, can use context to help them identify the words that they hear.

What Kind of Language Input do Blind Babies Hear?

Genia Lukin (Graduate Student); Elika Bergelson (Principal Investigator)

In this study, we used a collection of daylong recordings of naturalistic (normal everyday) language environments to track the kind of language input blind babies get from their parents. The families received a recorder and a vest (or shirt) with a special pocket that the babies wore for sixteen hours. We downloaded the recordings, divided them into segments, and (laboriously!) transcribed a random sample of segments throughout the day.

We wanted to know whether parents talk differently to blind babies than to sighted ones, as a way to provide them with more information about the world. Blind babies can't get information visually (because they're blind), but maybe they get more information through language input. We annotated every sentence parents said to their kids in two different ways: once for grammatical form of the sentence: for example, if the sentence was a declarative, like "this is a duckie," or an imperative, like "bring me your shoes." We also annotated sentences for the information structure, such as extensions, where parents respond to their babies by providing more information ("this is a duckie, it's blue.") as opposed to repetitions, which provide no new information.

We found that, generally, parents of blind and sighted babies use very similar kinds of language, both in terms of type and in terms of conversational content. But parents of blind babies tend to use fewer imperatives like "bring me your shoes", and slightly more declaratives like "this is a duckie." We completed this study and are in the process of writing up and submitting the results to journals and are doing more in-depth analyses with the daylong recordings!

Are Children's Representations of Psychological Intimacy Consistent with Their Theory of Mind?

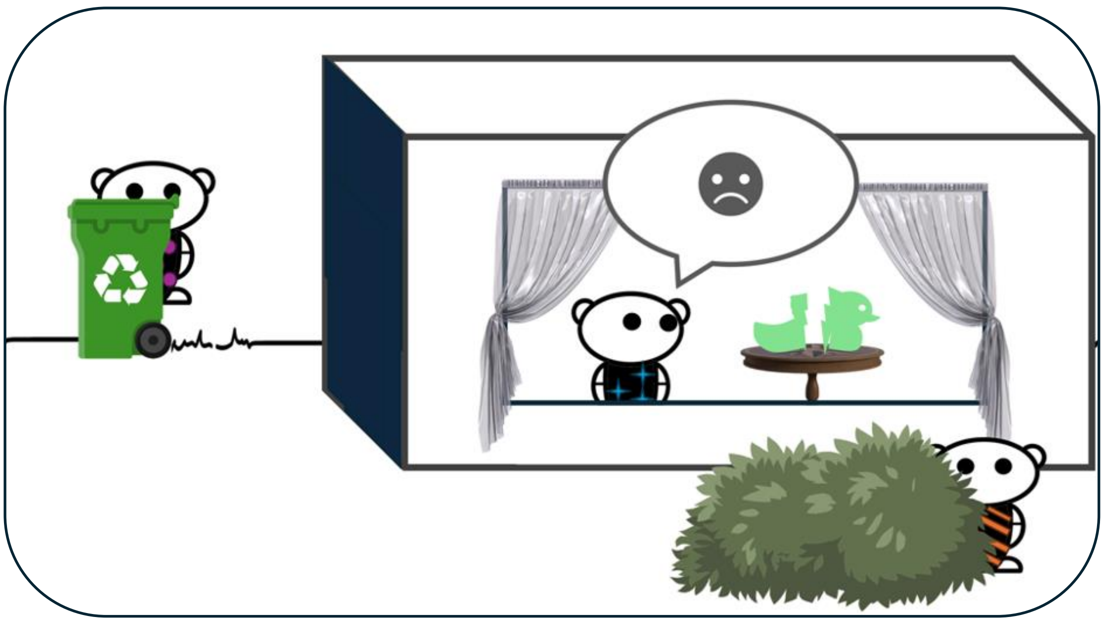
Herrissa Lamothe (Postdoctoral Researcher); Brandon Woo (Former Postdoctoral Researcher); Maya Hernandez (Summer Intern); Ashley Thomas (Principal Investigator)

We know that children can represent different ways in which people can be intimate. But how do they represent psychological intimacy – i.e., the ways in which being close to others affects how we reason about their minds? This study seeks to understand if children import what they know about the minds of others to structure their expectations about how the minds of two people who are in an intimate relationship are related.

What children know about the minds of others can be described as a "theory" of how minds work in general. Such a theory involves the idea that minds are hidden causal processes and states which can, nevertheless, be inferred (or "figured out") without being directly observed. One way to think about this, is that this theory of mind that children possess includes the idea that our knowledge about the minds of others are inferred.

If children are importing what they know about minds in general to represent how they think two people who are close will represent each other's minds, one thing they should expect is that two people who are close should be able to infer each other's minds, rather than relying on direct observation. Or, vice versa, they should be able to infer that someone who is able to infer the mind of another, rather than relying on observations about them, should be close to them. We start out by testing this second version of our hypothesis.

We piloted these scenarios and tested 11 children 6 to 9 years old. We showed them a set of stories depicting three robot alien friends. These robot aliens do not show their emotions on their faces or in the way they speak. Our robot alien friends are visiting the main character's house and decide to play hide and seek. The hiding places of the side characters vary. For example, in some scenarios, one side character hides in the bushes near the house by an open window, while the other side character hides in the yard bin further from the house.



The main character looks for their friends outside the house but doesn't find them. Eventually, they go look for them inside the house, where they encounter an event that distracts them from the game and elicits an emotion. The emotion is the result of a reasoning unique to the main character. In the various scenarios, the main character shares out loud to the room (without knowing that the side character in the bushes can hear) a combination of what they are feeling and why. In most of our scenarios, the side character who is by the window overhears what the main character says; but the side character who is in the yard does not hear anything. In some other scenarios, one or both of the side characters only overhears part of what the main character's shared with the room.

The timer ending the hide and seek game rings and both side characters enter the house. Both side characters say out loud how they think the main character is feeling (or in other scenarios *why* the main character feels the way they feel). Based on what they saw, the children in our study told us how close they thought the main character was with each side character. They also told us which side character they thought was closer to the main character.

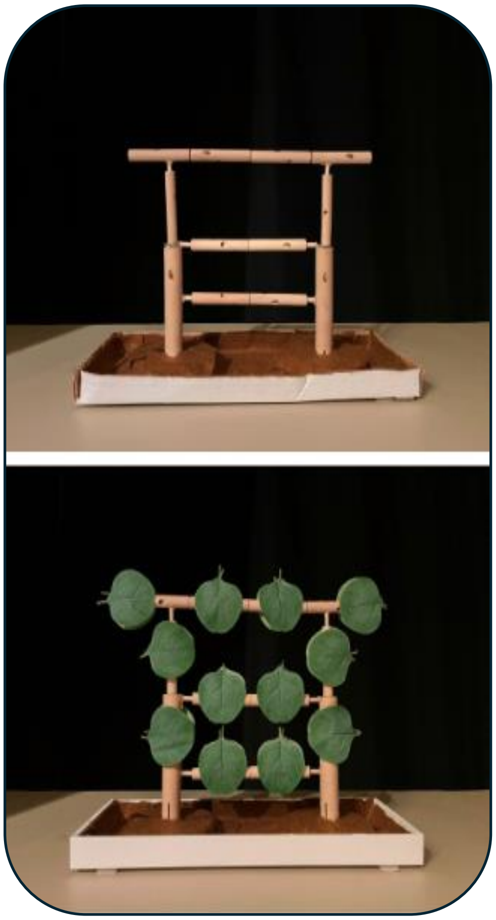
In our pilot data, the 6 and 7 year-olds tended to pick the side character who came to know the mental state of the main character by overhearing as being the closer friend. The 8 and 9 year-olds in our study tended to pick the side character who came to know the mental state of the main character by inferring (or "figuring it out") as being closer.

We cannot make too much of this pilot data, however, because of the small sample size, and because we had so many more 6-7 year-olds (N= 8) than 8-9 year-olds (N=3). In the future, we hope to test more children to see if this trend holds. We also would like to test adults to see how they think about psychological intimacy.

Infant Sensitivity to Plant Structure

Cristina Sarmiento (Lab Manager); Elizabeth Spelke (Principal Investigator)

When we look back in time evolutionarily, plants and trees have always been a part of our environment. Before the ease of shopping for food at grocery stores, we had to learn to forage for food and figure out from more knowledgeable others which plants were toxic and which ones were safe to eat. Past research has shown that infants and toddlers are hesitant to touch plants, which may be an evolutionary adaptation from when we foraged for food. How are infants and toddlers distinguishing plants from other living and nonliving things? What characteristics of plants are they using? We hypothesize that infants are using the hierarchical branching structure and/or leaves of plants to make this distinction. To explore this, we developed objects that had a natural growing structure (hierarchical structure) or an unnatural growing structure (looping structure), and that had leaves or no leaves. In addition to these objects, we had a pair of artificial plants with leaves and with no leaves. We also developed a questionnaire for parents to answer to see what infants' previous experiences with plants were and how this might influence their child's behavior during the study. We predict that children will take longer to touch the natural growing structures and the structures with leaves. Data collection has been completed and the analysis of our data is still ongoing!



Fingers as Tallies

Peggy Li (Research Associate); Sarah Chiang (Research Assistant); Crystal Gill (Research Assistant); Tyler Neri (Research Assistant); Peggy Yin (Research Assistant); Susan Carey (Principal Investigator)

Numbers are so essential to contemporary human activity—data processing, scheduling, trading—that it seems only natural that natural numbers (1, 2, 3, …) are, well, natural. But such number concepts may not be innate to humans after all: in cultures without counting systems ("one, two, three, …"), even adults tend to make errors when asked to match sets greater than 4 or to perform arithmetic. Also surprisingly, while most 2-year-old American children can recite numbers 1 through 10, they do not understand the logic of counting. For example, children may count a set correctly but fail to understand that the last word they reach when counting indicates how many items are in the set.

This project explores representations that may have supported the cultural invention of counting systems by testing 3- and 4-year-olds. Specifically, we focus on tallying, which served as a precursor to counting as a way for ancient human cultures to represent exact numbers. These tally systems often made use of fingers as tallies, where one finger represented exactly one object. We asked whether children could use fingers to represent an exact number of objects, even before learning how to count.

In one study, we explained to children that fingers in one-to-one correspondence with objects could help us represent how many there are ("We raise one finger for one donut. The fingers raised can show how many donuts there are."). Children were shown fingers raised and lowered as objects were added to or subtracted from a set. Then, to see whether children understood our explanation, we asked them to use their fingers to show how many objects when objects were added or subtracted from sets, and to show how many there were in pictures. We found that the idea of using finger tallies to represent sets may not initially be intuitive: many children, instead of raising or lowering the number of fingers appropriately, simply pointed to each object with their index finger. However, some children who had not worked out the logic of counting, did appreciate our instructions and tried to match the number of fingers they held up to the number of items presented.

Another study sought to find whether children could use finger tallies to track objects. For this study, children were provided finger tallies in one-to-one correspondence with stars entering and exiting a box. If children intuitively understand how tallies can represent exact large numbers, then we should expect to see improvement on this task compared to results from the same task without finger tallies, regardless of children's counting knowledge. We then asked the children whether all of the objects had come back or whether some remained in the box. We found that even children who did not know how to count could improve their performance on the task when provided with finger tallies. Overall, these studies begin to shed light on children's developmental understanding of tallying and the role tallying could play in the cultural invention of counting systems.

Do Children’s Social Reactions Differ Based on their Closeness to Others?

Megan Richardson (Research Assistant); Andrea Ventura (Research Assistant); Ashley Thomas (Principal Investigator)

We are interested in baby’s social reactions to people they know compared to people they don’t know. We showed babies videos of people they knew and people they didn’t know and measured their reactions (were they hiding their eyes, were they smiling? frowning?).

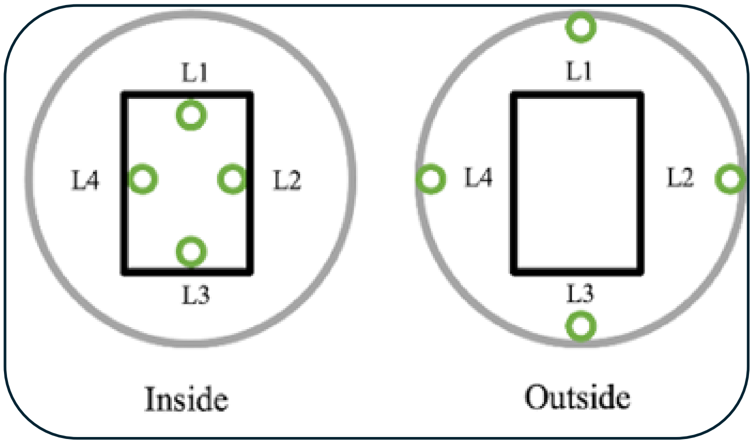
The importance of this study is that we know very little about how infants think about the people in their environments. We have only just begun collecting data so we don’t have any findings yet!

Infants’ Sensitivity to the Relationship between Objects and Boundaries

Ganzhen Feng (Visiting Graduate Student); Olivia Pownall (Research Assistant); Logan Smith (Summer Intern); Elizabeth Spelke (Principal Investigator)

Disoriented children can use the shape of a surface layout to retrieve a hidden goal within that layout. In daily navigation, it is also common to retrieve a goal outside the surface layout. However, it remains unclear whether children can use the shape of a surface layout to retrieve a hidden goal outside that layout.

To address this, our first pilot study investigated how children retrieve a hidden goal after disorientation in an environment with nested surface borders, where only the inner border is geometrically informative. We set up two experimental conditions to explore this. As shown in Figure 1, both conditions took place in a large circular room. In the inside condition, the goal was hidden in one of four containers (L1-L4) placed in the corners within a rectangular enclosure. In the outside condition, the goal was hidden in one of four containers (L1-L4) placed outside the rectangular enclosure, against the circular room's wall. Data from 10 children suggest that both 3- and 4-year-old children could successfully relocate geometrically correct locations in the inside condition (with an average accuracy of over 75%, indicating that most chose the geometrically correct locations in more than 3 out of 4 trials). However, 3-year-olds performed at chance level in the outside condition (with an accuracy of only 45%). We later discovered a confound: in the inside condition, the object was hidden right next to the enclosure, whereas in the outside condition, the objects were located farther from the enclosure.



Therefore, we adjusted the experimental setup and are conducting a new study. After the adjustments, we placed the four containers 6 inches from the corners on the outside of the enclosure for the outside condition, and similarly 6 inches from the corners inside the enclosure for the inside condition (see Figure 2). Currently, we have tested only nine younger children (under 3 years old) with the outside condition. Their average accuracy was 67%, suggesting that even children under 3 years old can successfully retrieve a hidden object outside the enclosure. We look forward to sharing updates on our discoveries as we continue to run participants!

How Children Tackle Power Imbalances: What do they Think is Fair?

Mack Briscoe (Graduate Student); Ashley Thomas (Principal Investigator)

Groups often navigate situations with limited resources. Frequently, those with greater control of those resources divide them in their own favor. How do children think about addressing these kinds of power imbalances?

In this experiment, we presented 6–8-year-old children with two novel groups sharing a limited amount of fruit on an island. They are told that one of these two groups is in charge. In one condition, the group in charge distributes fruit unequally in their own favor. In a different condition, the group in charge distributes fruit equally between everyone on the island. Afterwards, the experimenter asks whether the people on the island should change the way they decide who gets what. Should they make it so that the same group, the other group (which was not making decisions on how to split the fruit), or everyone from both groups is in charge?

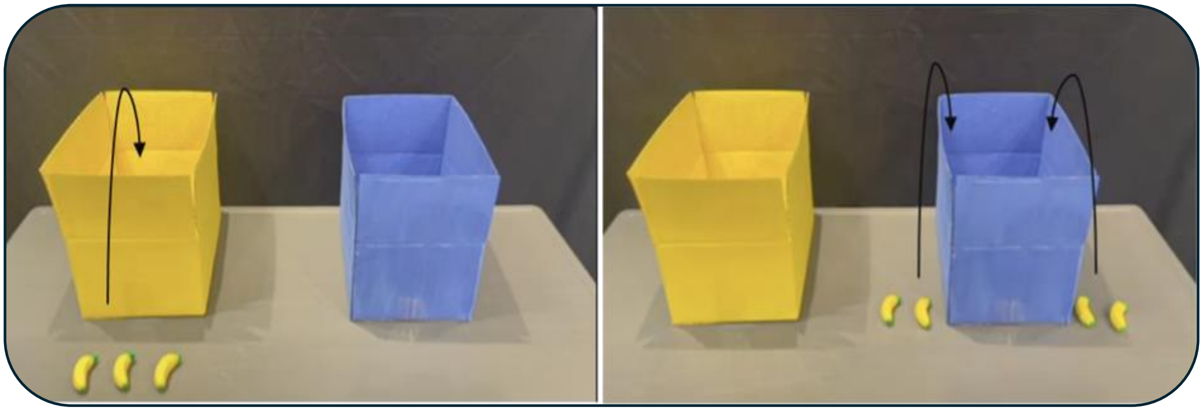
Currently, we're seeing that children have an initial preference to make it so that everyone in both groups is in charge, regardless of how resources were distributed. Interestingly, however, as children see more conditions, they develop a stronger preference to have just one group in charge, rather than both. We are currently thinking about follow up studies to make sense of this effect!

Children's Understanding of Set Representations

Michael Huemer (Postdoctoral Researcher); Milena Bodler (Research Assistant); Ria Genrich (Research Assistant); Elizabeth Spelke (Principal Investigator)

Previous studies suggest that 10- to 12-month-old infants can represent a maximum of three objects at a time (when representing the exact number of objects). However, children can exceed this working memory limitation by chunking multiple objects into sets. Research has demonstrated that infants fail to remember 4 individuals hidden in a box but succeed when presenting the objects as 2 sets of 2 before hiding them into the box. The critical question is whether children are combining 2 sets of 2 into 4 or are they representing it as 2 chunks?

To further investigate this question, we developed an online study designed to test this hypothesis. Children aged 18-24 months were presented with videos in which different numbers of various objects were placed into boxes. They were then asked to identify the box they believed contained more. Each child underwent at least three trials with the following combinations: 1 vs. 3, 1 vs. 4, and 2x2 vs. 3. We predicted that children would succeed in the 1 vs. 3 trials by selecting the box with more objects, and fail in the 1 vs. 4 trials, as they are not expected to represent four objects at once. For the 2x2 vs. 3 trials, which was the primary focus of our study, we did not make any specific predictions, treating it as an open question. If children represent 2 sets of 2 as 4 objects, they will successfully identify the box with 2x2 as more. However, if they represent 2 sets of 2 just 2 sets of, they might have no preference at all for one of the two boxes.

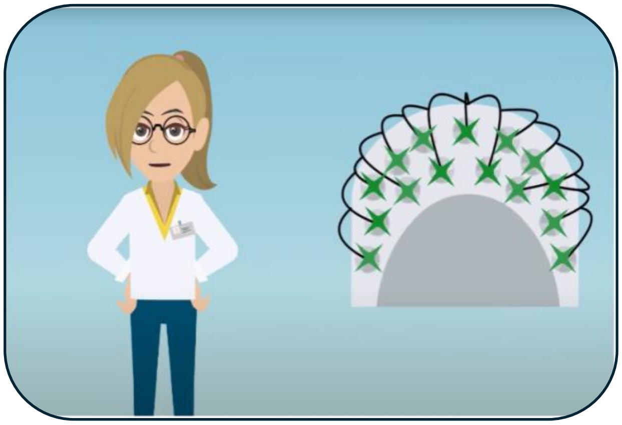


In our pilot study, children neither consistently succeeded in the 1 vs. 3 condition nor failed in the 1 vs. 4 condition. It seems that children this age have not yet developed a sufficient understanding of "more". We plan to repeat the study in an in-person format to simplify the selection process for the children (where an understanding of "more" is not necessary) and potentially obtain clearer results.

Solve a Mystery! Do Children Predict the Form of Upcoming Words?

Anthony Yacovone (Postdoctoral Affiliate); Briony Waite (Graduate Student); Jesse Snedeker (Principal Investigator)

In this study, we are investigating how children understand the words that they hear while listening to a story. As listeners, we must quickly turn incoming sounds into words and then use those words to build up meaningful sentences! Prior work has found that, instead of just passively listening to people speak, people also actively predict what someone is about to say. This process of predicting upcoming words seems to help us understand people better and allows us to notice when people make mistakes. However, there are still open questions about linguistic prediction and how this ability develops!



So, to study this phenomenon, we asked your child to watch a cartoon while we recorded their brain waves using electroencephalography (EEG). We looked at lots of children's brain responses to various words spoken throughout the story. Some of these words were perfectly normal (e.g. *cake*) while others were slightly mispronounced (e.g. *ceke* or *vake*). More specifically, the story contained two types of mispronounced words: one type had the same initial sound (*ceke* instead of *cake*), and the other type rhymed with the original word (*vake* instead of *cake*).

If children are expecting certain words to come next in the story, then these mispronunciations should be quite surprising to hear, resulting in larger brain waves! The size of these brain waves often reflects how difficult it was to understand the error in the story—so, we are also interested in whether there are different sized responses to errors like *ceke* or *vake* when the original word was supposed to be *cake*. If the error is very similar to the expected word (e.g. *ceke* and *cake*), then the brain responses should be relatively small. We have evidence that this is true for adults, and the remaining question is if this is true in children!

We are just wrapping up data collection for this study, so please stay tuned for updates in our newsletter next year. Thank you for participating!

Unpacking Toddlers’ Early Understandings of Groups

Mack Briscoe (Graduate Researcher); Christina Steele (Graduate Researcher); Charlston Stovall (Summer Intern); Ashley Thomas (Principal Investigator)

From a young age, we all notice and react to the groups people belong to. Whether it’s at school, work, or in our communities, we’re constantly picking up on who’s part of our “in-group” and who isn’t. Even kids are quick to notice these group dynamics. For example, research shows that children as young as 3.5 years old already expect people from their own group to support them, and they might even think it’s normal for people from other groups to be less friendly.

Interestingly, babies are also tuned into these group differences, even before they can talk. They tend to prefer people who speak the same language as their caregivers and expect people who spend time together to help each other out. For example, if three characters are playing together, babies are more likely to think that those characters will support each other during conflicts.

However, scientists are still trying to figure out exactly what babies and young children understand about groups. Are they really thinking about "groups" like adults do, or are they more focused on individual relationships? And how do they learn about new groups, especially since group memberships can be different depending on where they live?

We are currently running a study to explore whether and how babies recognize group members, specifically testing whether they expect members of the same group of shapes to act similarly and be 'surprised' when they don't. We hope this study will show us whether babies may have early abilities just like we do as adults to recognize social groups in their world!

Unlocking Word Comprehension: Do Determiners Help Infants Recognize Familiar Words Faster?

Jasenia Hartman (Postdoctoral Researcher); Elika Bergelson (Principal Investigator)

Around 6 months of age, infants know the names of many common words. They know proper nouns, like *mommy* and *daddy*, as well as the names of objects they commonly see, such as *cup* or *hand*. However, around 12-14 months, something remarkable happens; they become much better at understanding familiar words. In this study, we seek to answer why older children are much better at understanding words than younger ones?

One reason older children understand words better than younger ones may be because they have more language knowledge that helps them predict how speech will unfold. For instance, research shows that infants know that determiners come before nouns (e.g., *the* dog). Even more remarkable, studies have found that infants as young as 12 months are slower to recognize familiar nouns (e.g., dog) when the determiner is replaced by a nonsense or incorrect word (e.g., "Look at *po* dog" or "Look at *was* dog" vs "Look at *the* dog"). However, we don't know how early this knowledge emerges and how it might relate to word comprehension.

To answer these questions, we are testing infants ages 10 to 16 months on two eye-tracking experiments. In the first eye-tracking experiment, we showed your child two images (e.g., a picture of a dog and a bear) on a screen as they listened to sentences that were either grammatical (e.g., Look at *the* dog) or ungrammatical (e.g., "Look at *po* dog" or "Look at *do* dog"). In the second experiment, we show them two pictures of common objects while playing sentences containing one of the words as a way to measure which words they know. As they do both experiments, we record their eye movement to each image. With both experiments, we can see whether children's expectations about determiners and nouns occur before the comprehension boost. We are currently still undergoing data collection for this study, so please stay tuned for updates in our future newsletter. Thank you for participating!

Representing New People as Individuals

Brandon Woo (Former Postdoctoral Researcher); Haowei Peng, (Research Assistant); Andrea Ventura (Research Assistant); Ashley Thomas (Principal Investigator)

Younger babies usually have trouble representing distinct features of individuals and objects, when they're hidden from view. For example, when a duck and a ball alternatingly emerge from behind a wall, older babies, children, and adults understand that there should be two objects behind the wall. Younger babies, by contrast, don't; they seem to just think that the duck and the ball (which they never saw at the same time) could have just been one object.

In our first study, we asked whether younger babies (who usually don’t represent a duck and a ball as distinct kinds) would represent their own caregivers and a stranger (another baby’s caregiver) as distinct kinds. To our surprise, we found evidence that young babies succeeded at representing two adults as two distinct people, regardless of whether their caregiver was one of those adults. This stands in contrast to much past work suggestive that younger babies have trouble representing distinct kinds of objects and people, when those objects and people are hidden from view.

We recognize, however, that the people in our videos may have been more engaging than those of past work: We had instructed them to smile, speak in an upbeat tone, and look at the camera. We are now testing the possibility that babies better represent two people as distinct kinds when those people are engaging than when those people are not engaging.

Do Emotions Support Infants’ Representations of People?

Brandon Woo (Former Postdoctoral Researcher); Andrea Ventura (Research Assistant); Ashley Thomas (Principal Investigator)

As mentioned above (see “Representing New People as Individuals”), younger babies usually have trouble representing distinct features of individuals and objects, when they’re hidden from view. Here, we asked whether babies could use social emotions to represent new characters. Although we had promising pilot data, the overall pattern of findings was mixed, and we are figuring out next steps.

Children's Early Understanding of Family Networks

Christina Steele (Graduate Student); Ashley Thomas (Principal Investigator)

We're exploring how young children understand family relationships and social networks. From a young age, kids are surrounded by people who form their social world—like parents, grandparents, and other caregivers. This study aims to see how well 4- to 5-year-olds grasp these family connections. Do they understand who’s who and how they’re related, even before they can explain it?

Past studies show that young kids tend to struggle with definitions of family words like "grandmother". However, while kids may not always know these specific definitions, our study aims to see whether kids may have some early knowledge of family social networks. To find out, we ask kids who they think their parents would turn to for comfort as well as the common definitions of family words. We compare their answers with who their parents say they are close to in order to see how children's understanding of family reflects these social ties.

Ultimately, this research will help us understand how kids build their early ideas about family, which is a key part of learning about social relationships.

Do 3-Year-Olds Reason More Readily About Their Caregiver's Beliefs Then a Stranger's?

Gabriel Chisholm (Research Assistant); Abbey Charlamb (Research Assistant); Brandon Woo (Former Postdoctoral Researcher); Ashley Thomas (Co-Principal Investigator); Elizabeth Spelke (Co-Principal Investigator)

Theory of mind (ToM) refers to humans' ability to reason about others' mental states such as their beliefs. This capacity is central to social interactions as it facilitates cooperation and prevents miscommunication that can arise from differing perspectives, as in cases where one holds a false belief not aligned with reality. Whilst adults readily infer false beliefs, young children struggle with this skill until around ages 4-5. Although the importance of social relationships for developing ToM is well-established, less research has focused on how these relationships themselves may influence children's performance on false belief tasks. Prior research assessed children's reasoning about individuals with whom they shared no close relationship.

This study aimed to test whether the closeness of the child's relationship to this individual may influence their belief-reasoning. This study tested three-year-old children (N = 41) in an online adaptation of the unexpected-contents false belief task. The study compared children's ability to reason about their caregiver's or a stranger's false belief about a deceptive container's contents. The findings revealed that children did not significantly differ in their performance across stranger and caregiver trials.

This suggests that the child's socially close relationship with an individual does not impact their ability to infer that individual's false belief. This has theoretical implications for research into children's ToM development which highlight the salience of social factors in children's false belief reasoning. Overall, the study provides novel insight into young children's theory of mind capacities by manipulating the social closeness of the individuals about whom they reason.

Can you Choose Who I Choose? Children’s Understanding of Event Participants

Irene Canudas Grabolosa (Postdoctoral Researcher); Hanna-Sophia Shine (Lab Manager); Jesse Snedeker (Principal Investigator)

In this study, we are investigating how children understand events and the people involved in them. We’re particularly interested in how abstractly children represent these events and how easily they can use these representations. For instance, if they see a ballerina tapping a fireman and a skater pushing a princess, can they group the ballerina and the skater together as the “doers” of the action?

In our online, unmonitored study, we showed children short videos featuring two characters. In each video, one character acts on the other, such as a princess poking a prince. A virtual experimenter then systematically selected one character from each pair, either always the doer of the action or always the receiver of the action. After a few examples, the children were asked to choose by themselves. We’re interested in seeing whether they can figure out the rule of “select the doer” or “select the receiver” and apply it to their selections. We have just begun this study, and so far, seven children aged 4 to 5 years have participated. Stay tuned for our findings!

Children's Understanding of Close Friendships

Ayana Lomas (Research Assistant), Brandon Woo (Former Postdoctoral Researcher), Ashley Thomas (Principal Investigator)

Studying how children comprehend social relationships is essential for understanding the development of social reasoning. One type of relationship that grows increasingly significant throughout development is friendship. A key aspect of friendship for adults is the desire to understand each other better through learning more about each other. Previous research has shown that children view both intimate and non-intimate knowledge of a person to be important information to hold about a close friend. However, it is unclear whether children expect those in closer relationships to have a greater desire to learn this information about one another to seek mutual understanding.

Therefore, this study investigated whether children believe that people in closer relationships have a stronger desire to learn more intimate information about each other. Specifically, we aim to see if children expect those in closer relationships to seek more information about their friends. Data collection for this project is ongoing!

What Do Children Know About Numbers They Do Not Yet Know?

Adelaide Kelsey (Research Assistant); Yiqiao Wang (Graduate Student); Elizabeth Spelke (Principal Investigator)

Children go through distinct stages as they acquire cardinal meanings of number words. Around the age of two, children learn to count up to ten or so. At this point, children don't have a cardinal understanding of these numbers, meaning that they don't understand what each number word in their list actually represents. Previous research has shown that children learn the meaning of each of the number words in sequence over the next few years, until at some point they learn the cardinal principle, or the idea that counting can be used to identify and generate sets of larger numbers. While the process of learning the cardinal principle has been well-studied, it is still unclear how much children know about the large numbers that they are able to count to but not generate a set for.

In this study, we are examining what children know about numbers they "do not yet know" or numbers that they can't generate a set for. We are currently finishing up a pilot version of the study where we have been testing children ages 32-51 months over Zoom. Each participant plays three short number games. In the first game, they are given a number word between one and six and asked to put that number of objects on a plate. In the second game, they are given a short storyline about two hungry bears. Children are then presented with three visual sets of berries and told how many berries each bear wants to eat; they are asked to pick which set represents each of the number words. This task is designed to test whether participants have any partial understanding of numbers that they don't know. In the third game, they are asked a couple of questions about the order of numbers between one and ten as another way of measuring their current number understanding.

Preliminary results have shown that children who understand the cardinal principle are able to succeed on all of these tasks, as expected. Children who don't yet know the cardinal principle have a harder time with the second task, but the results are still inconclusive as to whether they have any partial understanding of larger numbers. We are currently working to brainstorm next steps and looking forward to continuing this study!

Do Kids Flexibly Predict Upcoming Words?

Margaret Kandel (Graduate Student), Danielle Novak (Research Assistant), Jesse Snedeker (Principal Investigator)

As adults comprehend language, they can predict what words or information will come next. Our lab is interested in when and how these predictions occur and whether young children are similarly able to predict upcoming language. There is evidence that adult language prediction is flexible and more likely to be engaged in contexts when words are more predictable. This study investigates whether young children's language processing is also flexibly predictive.

We are conducting this study with young children who speak American English. In the experiment, children are playing a game with Captain Coral and Polly the Parrot in order to help Polly learn English. In each round of the game, Captain Coral says two words. Then, Polly shows a picture that she thinks matches one of the two words. The participant's job is to tell Polly whether or not the picture matches. Sometimes the words Captain Coral says are related to each other, and sometimes they are not. For some participants, the word pairs are related 80% of the time (meaning that the second word of each pair is usually predictable), and for others, the word pairs are related only 20% of the time (meaning that the second word is usually unpredictable).

As participants complete the experiment, we record their scalp electricity using electroencephalography (EEG). We can measure changes in scalp electricity in response to the second word in each pair in order to identify whether participants predicted the second word based on the first word. Our analysis will assess whether participants are more likely to predict the second word when these words are usually predictable (the 80% related condition) than when they are not predictable (the 20% related condition), which would indicate that young children flexibly modulate their linguistic prediction. Data collection for this study is still ongoing, so stay tuned for results!

Do Children Infer Close Relationships from Rarer Actions?

Mack Briscoe (Graduate Student); Min Feldman (Summer Intern); Ashley Thomas (Principal Investigator)

There are several actions that we reserve only for the people we are closest to. For example, think about who you would be willing to hold hands with (and compare that to who you would be willing to shake hands with). Think about how many people you would be willing to hold hands with. Probably not too many. In this study, we are interested in whether children expect that actions which are performed less frequently (like hand holding) tend to belong to closer relationships.

To test this, we introduce 6-8 year old children to novel characters in a park. A character continuously runs into people and says hello, each time performing a novel greeting action (e.g., headbutting and knee touching). Most of the time, the characters greet each other in the same way (e.g., they headbutt). Once, the characters greet each other in a different way (e.g., they touch their knees together). We then ask children which action they think is done with best friends. We also ask them whether they would like to be friends with someone who does the uncommon action with most people, or someone who does the common action with most people.

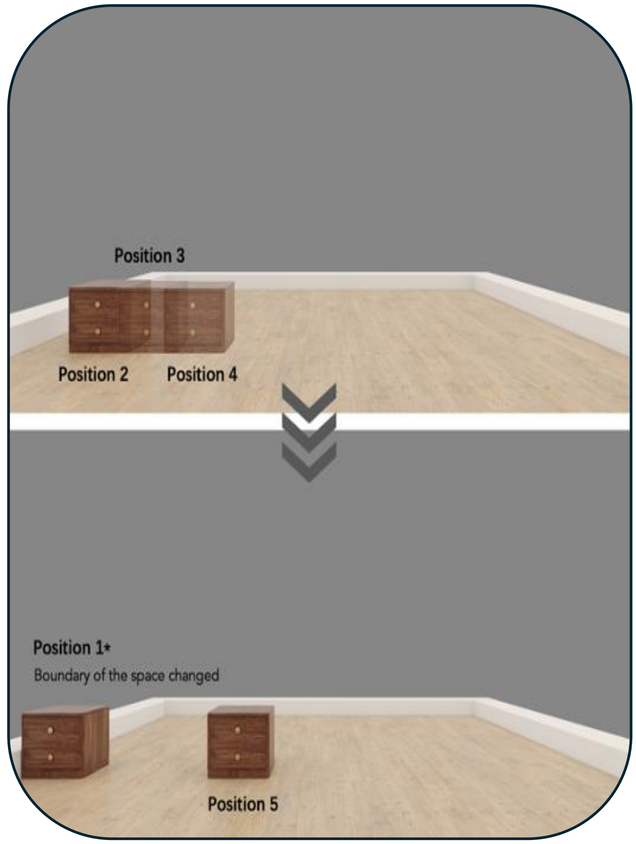
We just started data collection, and we are looking forward to sharing results as they come in!

Infants' Sensitivity to the Relationship between Objects and Boundaries

Ganzhen Feng (Visiting Graduate Student); Muyuan Xu (Research Assistant); Elizabeth Spelke (Principal Investigator)

Spatial boundaries play a special role in our spatial knowledge. Previous studies on children indicate that they are highly sensitive to changes in the shape of a room caused by the slight alterations of its boundaries. This raises the question of whether infants also perceive changes differently when a change in an object's position induces a change in the shape of spatial boundaries.

To investigate infant's sensitivity to the relationship between objects and boundaries, we are running pilot studies on infants aged 4 to 11 months. In the study, we first show the infants multiple pictures of a cabinet located in central positions within a space (positions 2, 3, and 4). We show the pictures repeatedly so that the infants are used to these positions. We then show two new positions - another middle position (position 5) and a position touching the wall (position 1) which changes the shape of the boundary of the space. We would like to see if infants are more sensitive to the variation in the cabinet's position when the boundary of the space changes. We are measuring how long infants look at each picture when the cabinets are in different positions. If the infants are more sensitive to the position of the cabinet that changes the boundary of the space, we would expect a longer average looking time for the cabinet in position 1 than position 5.



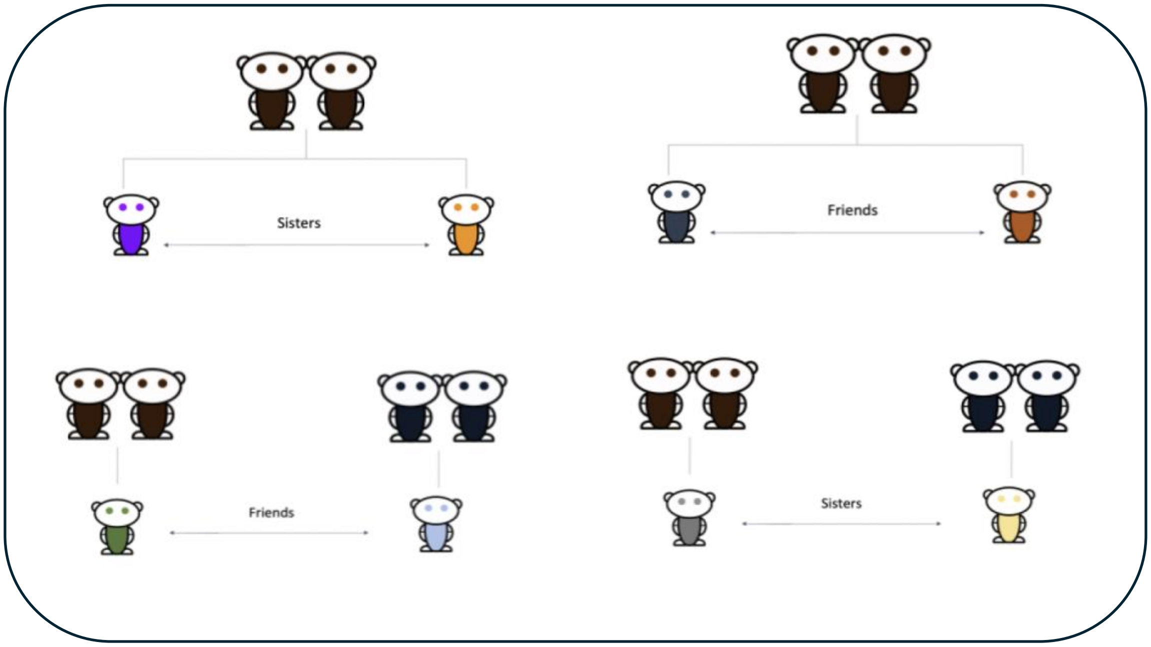
So far in most of our pilots, we are seeing a slightly longer looking time towards the position 1. This study is ongoing, and we are very excited to see the results!

Do Children Think That Calling Someone Family Makes Them Close?

Megan Richardson (Research Assistant); Ashley Thomas (Principal Investigator)

This project aims to find out if children use kinship terms like "sister," "brother," "aunt," or "uncle" to understand how close they are to someone, even if they are not related biologically. Adults often use these terms to show a close relationship despite no genetic connection. We know that people use different clues, such as being physically close, sharing saliva, and understanding each other's thoughts, to determine social closeness. Our goal is to see if calling someone "family" can indicate a close relationship for children.

We showed 5-9-year-old children four different relationship scenarios. In each scenario, there were two characters who either shared the same set of parents or had different parents. The characters either called each other "brothers" or "sisters" (matched to the child's gender) or referred to each other as "friends." We then asked the children four questions per scenario to assess how close they thought the two characters were. First, we used a visual aid with overlapping circles to represent different levels of closeness. Next, we asked the children how likely it was for the characters to share a secret, share a spoon to eat ice cream and hug each other.

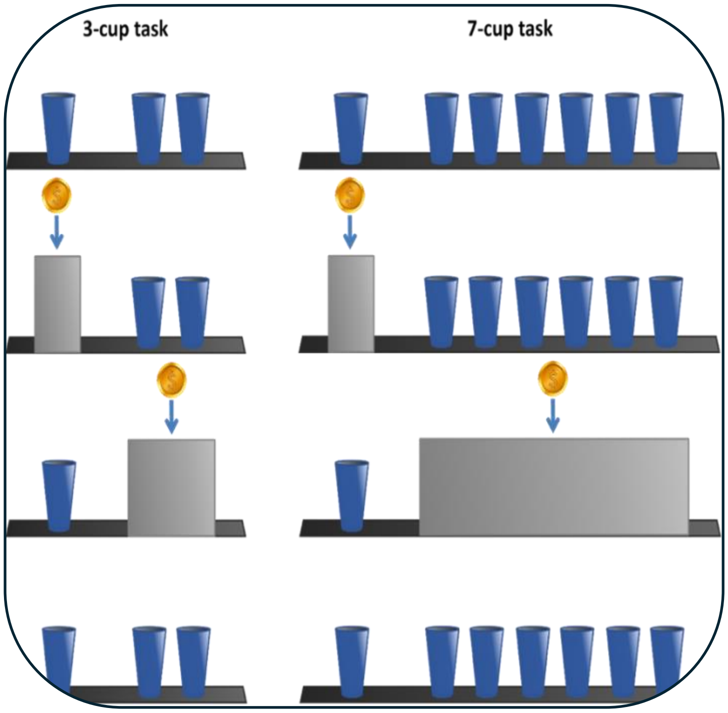


In our pilot data, we found that children tend to view genetic connections as a slightly stronger sign of social closeness than using kinship terms. However, the strongest indication of closeness across all measures was when both cues were present: the characters shared the same parents and called each other siblings. On the other hand, the weakest indication of closeness across measures occurred when neither cue was present: the characters had different parents and called each other friends. We are excited to take a deeper look into this data and are very grateful to the families who participated in our study!

Which Cup do You Want to Pick?

Irene Canudas Grabolosa (Postdoctoral Researcher); Michael Huemer (Postdoctoral Researcher); Simon Born (Research Assistant); Maia Hoffenberg (Research Assistant); Susan Carey (Principal Investigator)

In this study, we investigated children's understanding of multiple possibilities using the 3-cup and 7-cup tasks. In the 3-cup task, a coin is hidden in one occluded cup and another in an occluded pair. Choosing the single cup is the safer bet, but previous studies show that 3-year-olds choose from the pair almost half the time.



To understand why, we increased the number of cups in the study. Research with other species found that while chimpanzees faced with the same 3-cup task choose the single cup as often as 3-year-olds, they choose the single cup more frequently as the number of cups on the unsure side increases. This suggests that with more cups, it's easier to see the single cup as a sure bet, while each cup in the larger set is more likely to be empty.

To investigate whether children would also see it this way, we tested 24 3-year-olds using both the 3- and 7-cup tasks. Our results show that 3-year-olds picked the single cup around 50% of the time, regardless of the number of cups, thus diverging from what we have observed in other species. We are currently analyzing the data to understand what these trends tell us about their understanding of possibility.

Can preschoolers track exactly five objects?

Yiqiao Wang (Graduate Student), Susan Carey (Co-Principal Investigator), Elizabeth Spelke (Co-Principal Investigator)

This project aims to study the development of children's integer concepts. As adults, we know some key properties of integers. For instance, we have an exact representation of each integer that we can distinguish each one from the others. Previous research has shown that there are two preverbal systems that can support our exact representations of small numbers (i.e., numbers up to three or four). However, it's still an open question where the capacity to represent large, exact numbers comes from. We hope to find an answer through a case study investigating young children's representation of the number five. We chose the number five because it's where the two preverbal systems reach their limitations.

In two baseline studies, we recruited children aged from 36 to 54 months who speak English as their primary language. Each child played two games with an experimenter in a Zoom session. The first game was to measure whether children could track and represent exact numbers of objects. In this game, children saw certain numbers of stars hidden in an empty box. On half of the trials, they saw all the stars come out of the box; on the other half, they saw all but one star come out. At the end of each trial, children were asked whether all the stars had come out. The second game was to measure children's number word knowledge. Children were asked to put certain numbers of objects on a plate upon hearing the number words. This game sorted children into two groups: Children who have understood how counting works and what the number word "five" means (i.e., CP-knowers) and those who haven't (i.e., Subset-knowers). We expected that CP-knowers could rely on the counting procedure to successfully track five stars, but not the subset-knowers. We found that only 30% of the CP-knowers succeeded at tracking exactly five stars and subset knowers could not track five stars.

We think one possible reason that CP-knowers did not perform well is that they might not spontaneously deploy the resources they have and use counting as a strategy to track the stars. In a follow-up study, we prompted children to count the stars before they go into the box. If counting is one of the resources available to children, CP-knowers, but not subset-knowers, should perform better than those in the baseline studies. Our results so far confirmed that CP-knowers, but not subset-knowers, benefited from the counting prompt. We also explored whether hierarchical set-building capacity supports children's exact representation of five. In two follow-up studies, we chunked a set of five stars into a set of two stars and a set of three stars using spatiotemporal, linguistic, and/or color cues. If tracking a set of five by tracking a set of two and a set of three is within children's hierarchical set-building capacity, we expected all children to perform better than those in the baseline studies. So far, we failed to find evidence supporting this prediction. In another follow-up study, we explored whether understanding one-to-one correspondence serves as one of the resources available to children. We provided children with fingers that are in one-to-one correspondence with stars and found that children from both groups benefited from the one-to-one correspondence cues and outperformed those in the baseline studies. Our next step is to explore whether children see fingers as tallies and can establish one-to-one correspondence themselves to track five stars.

Children's Early Understanding of Groups

Christina Steele (Graduate Researcher); Ashley Thomas (Principal Investigator)

We're studying how children think about sharing, specifically when it comes to sharing saliva—like when they share food or drinks—with other kids. To do so, we ask children if they expect others to be willing to engage in this type of sharing with children of a different social group. By looking at how kids approach this behavior, we hope to learn more about how children's ideas about groups might influence their decisions in everyday social interactions. This will give us insights into how early social behaviors and attitudes about groups develop.

Predicting Words in Stories

Briony Waite (Graduate Student); Tanya Levari (Postdoctoral Researcher); Jesse Snedeker (Principal Investigator)

In this study, your child listened to a story while we recorded their brain activity. They wore a cap with lots of attached electrode wires. We are looking at the brain's response to each word in the story to see which features (e.g. frequency, or how often you encounter a word in your daily life, and predictability, or how expected a word is in the context) help us understand what we are hearing.

Studies using EEG with adults have discovered that there is a specific brain wave that happens when a person hears a word, called the N400 wave. The size of this brain wave changes depending on how easy a word is to understand and incorporate into a sentence. For example, when a word is very frequent, like "dog", the N400 wave is smaller than when a word is less frequent, like "axolotl." In addition, the wave is smaller when a word is very predictable, and larger to words that are surprising! For example, imagine hearing the following: "When I go to the movies, I love to snack on buttered… You wouldn't be very surprised if the next word was "popcorn," but you would be very surprised if you heard "toast," even though both words are relatively frequent. The size of the N400 brainwave would show exactly that – the N400 wave would be smaller if you heard "popcorn" and larger if you heard "toast."

In our study we are interested in seeing when the ability to predict upcoming words develops and how it changes as children age. In addition, your children completed a vocabulary task where they matched words to pictures. This task will allow us to see if the ability to predict words develops with children's age or their language ability. Thank you so much for participating!

Exploring Children's Knowledge of Plant Growth and Structure

Sanghee Song (Visiting Postgraduate Research Fellow); Elizabeth Spelke (Principal Investigator)

Before industrialization, people and animals lived among many different plants. Knowing how to identify and understand these plants was crucial for daily life. Our study explores how young children learn about plants today. We invited 24 children, aged 3 to 8 years, to play two fun, interactive games online for 15 minutes.

In the first game, children guessed how a plant would look after it grew a bit more. Plants have unique growth patterns because of how they capture sunlight and distribute water and nutrients. Unlike animals, which grow larger bones, plants grow differently. Our early results show that children can recognize these growth patterns. In the second game, children learned how plant branches support weight. They figured out how different parts of a plant can support hanging objects based on how close or far they were from the main stem. Previous studies suggested that even 5-year-olds struggle with understanding weight and distance in similar balance beam tasks. However, our study found that even younger children could use these concepts to find the basket which will hold the toy without bending or breaking.

Next, we'll study children's expectations on plants in motion, how they understand plant growth over time, and whether this knowledge is innate or learned. Stay tuned for more discoveries about how kids make sense of plants!

Prediction in Children with and Without Autism

Tanya Levari (Postdoctoral Researcher); Briony Waite (Graduate Student); Hanna-Sophia Shine (Lab Manager); Jesse Snedeker (Principal Investigator)

In this study, your child played many games, both in-person and on Zoom. For example, we asked your child to find smiley faces among pictures of real faces, tap along to a beat, and listen to a story! For some of the games, they were set up for an electroencephalogram (EEG) recording, and we recorded their brain responses while they completed different tasks.

These games might not have seemed connected, but we think they will help us understand different aspects of prediction; how do our brains find patterns in the world and how do we use those patterns to anticipate what we might experience next! In this study we are interested in seeing if there are differences in how children with and without autism make predictions.

For example, in one game, your child was asked to first listen and then tap along to sequences of sounds. This sequence of sounds had a predictable pattern but occasionally a sound was either omitted or delayed - breaking the pattern. By seeing your child's brain responses to these different errors, we can get an understanding of the kind of information being used to make predictions and how such predictions are updated when something new happens.

Your child also listened to a story while we recorded their brain activity. We are looking at the brain's response to each word in the story to see whether children's brain waves, like those of adults, are sensitive to various word features, such as frequency and predictability. This helps us understand linguistic prediction. Studies using EEG with adults have discovered that there is a specific brain wave that happens when a person hears a word, called the n400 wave. The size of this brain wave changes depending on how easy a word is to understand and incorporate into a sentence.

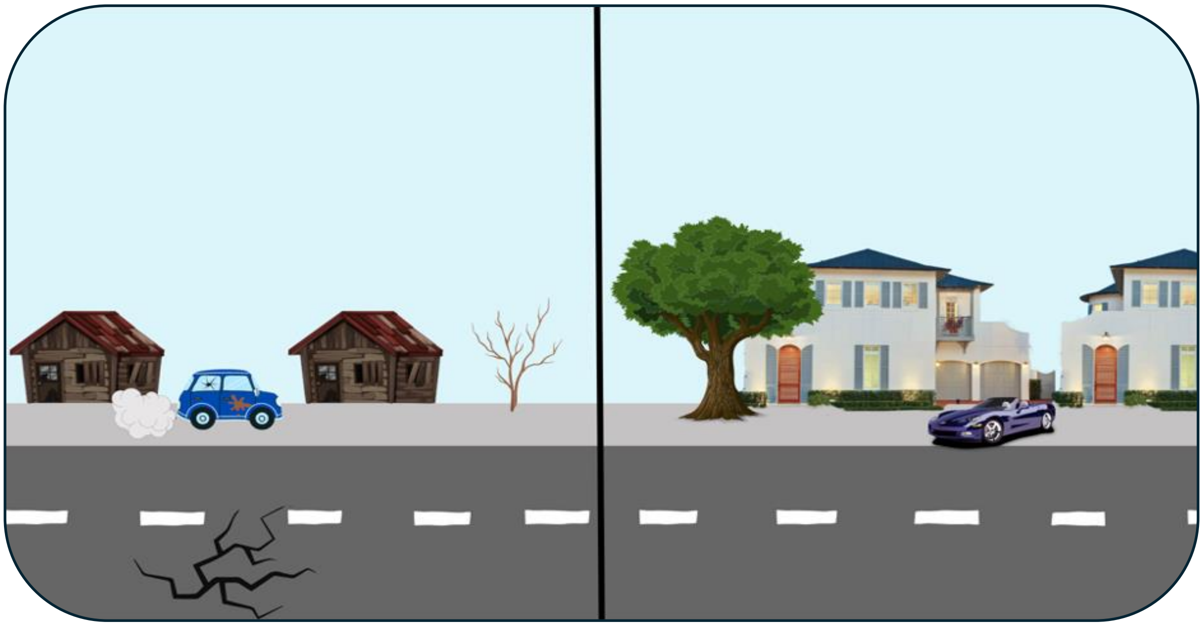
For example, when a word is very frequent, like "dog", the n400 wave is smaller than when a word is less frequent, like "axolotl". In addition, the wave is smaller when a word is very predictable, and larger to words that are surprising! For example, imagine hearing the following; "On a windy day Johnny liked to go fly his..." You wouldn't be very surprised if the next word was "kite", but you would be very surprised if you heard "blimp". The size of the n400 brainwave would show exactly that – the n400 wave would be smaller if you heard "kite" and larger if you heard "blimp".

Our data so far has shown both similarities and differences in the way that children with and without autism predict information, however, we are still in the process of collecting data for this study and it is too soon to know what we will find. Stay tuned for more results next year!
We loved seeing families in person for this study. Thank you so much for participating!

Children's Use of Accent as a Cue to Social Status

Denisse López (Lab Manager); Christina Steele (Graduate Student); Ashley Thomas (Principal Investigator)

This project seeks to explore whether children use accent as a cue to infer social status. While previous research has looked at children's use of gender (Mandalaywala et al., 2020) and race (Mandalaywala et al., 2020; Olson et al., 2012) to determine social status, it is yet to be established whether they use accent in the same way. We showed 6- to 8-year-old children characters who spoke with different accents (e.g., American, British, Colombian, Chinese, Indian, and Turkish). We then asked the children to rank these characters using a subjective social status ladder. Additionally, we showed them pictures of high-status and low-status neighborhoods and asked where they thought each character might live. The project is currently undergoing data collection.



Using Storybooks to Improve Number and Social Emotional Understanding in Toddlers

Cristina Sarmiento (Lab Manager), Sanghee Song (Research Assistant), Caitlin Conolly (Research Assistant), Elizabeth Spelke (Principal Investigator)

Once children enter formal schooling, they need to learn numerous things such as learning about their teachers and peers, learning about their environment, and learning about concepts such as numbers and reading. A foundation of pre-academic skills like number and social-emotional understanding can help children with this transition to formal schooling. To help children build their number and social-emotional skills in a fun and engaging way, we have two developed storybooks (number and emotion) that touch upon these skills. We predict that children who receive the number book will improve in their number skills, and children who receive the emotion book will improve in their social-emotional skills.

In the first book, the number book, two friends are searching for at least two more players for a fun game of tag. As they encounter groups of friends varying in number, they have to think about how these numbers combine to make other numbers, and whether those numbers may be exactly enough, or not quite enough for a game of tag. In the second book, the emotion book, the same two friends are trying to find guests for a fun birthday party, but soon discover that everyone has different feelings and moods. The friends have to think about how they should talk to or act with different friends depending on how they feel, and how they can help in different emotional situations.
To make sure we can assess the effects of our storybooks, we created games on numbers, emotions, and vocabulary. We piloted these games with 3-year-olds to make sure our games were fun and the right difficulty level.

We then piloted these games and storybooks together with 3-year-olds. Participants were mailed one of the storybooks to their homes. They met with researchers on Zoom to play a version of our games and were instructed to the read book at least 4 times at home throughout the next few weeks. After at least 2 weeks, participants met with the researchers again on Zoom to play a different version of our games and to read their favorite excerpt from the storybook.

Pilot results have shown that our emotion book seems to improve emotion skills, but the number book does not seem to improve number skills. We are working on improving our number games to better reflect the number skills touched upon in the storybook. Based on participant feedback, we have also edited the storybook. We hope to pilot our games and storybooks again soon!

How “Fine-Tuned” is a Baby’s Word Knowledge?

Lilli Righter (Lab Manager); Elika Bergelson (Principal Investigator)

In this study, we use eyetracking to ask whether babies start out with very specific or very vague ideas of what words sound like and what they mean– and how those changes over their second year of life! For example, to learn the word *dog* in English, you have to learn that it’s not pronounced “tog” or “dug,” even though those words sound pretty similar. You also have to learn what’s a dog and what’s not: it’s probably pretty easy to rule out a banana, but what about other furry four-legged friends? It might be harder to know right away that a cat isn’t a good example of a dog! Second, we wonder if you have to be really good at identifying the way a word sounds *before* you can narrow down what it means, or the other way around.

We put two pictures on the screen during each trial of the study, and we play a recording that says something like, “Find the dog!” During some rounds, the two pictures might be a dog and a cat, or a dog and a banana. During other rounds, we might show a dog and a banana, but we will mispronounce *dog* as “doog.” Based on how long a baby spends looking at each picture, we can infer what they think that word refers to. Babies do both types of trials in the same study session, so we can look at their sound skills and meaning skills at the exact same age!

We’re a little more than halfway done with this study: 91 out of our goal of 160 babies have participated in this study! So far, it looks like kids get better at identifying a word’s meaning as they get older, no matter what the distractor image is. It’s more or less just as easy to find a dog when there’s also a cat on screen as when there’s a banana on screen. This tells us their categories for what a word refers to might be pretty clear cut from an early age! Second, we find that their idea of what a word sounds like gets more specific as they get older: they start out treating *dog* and *doog* pretty equally but have more of a preference for the correct pronunciation as they get older. We’ll see if these patterns are significant with a full sample of babies!

Infant’s Representation of Objects in Physical Tracking

Yichen Li (Graduate Student); Brandon Woo (Former Postdoctoral Researcher); Elizabeth Spelke (Co-Principal Investigator); Tomer Ullman (Co-Principal Investigator)

We are interested in how people represent objects differently when they’re tracking them physically (say, to grab them) vs. to recognize them visually. This project examines the early development of this difference. Studies in cognitive development show that babies below 12 months do not use fine-grained form information to track objects (Xu & Carey, 1996; Xu, 2005).

That is, when they see a toy elephant go behind a screen and a ball come out, they don't seem to think there are two different objects behind the screen. But infants can certainly tell the difference visually between a ball and an elephant (Wilcox et al., 2010, show infants are certainly able to individuate objects based on shape, pattern, and color). We interpret these findings as showing that infants may be relying on rough approximations for physical tracking: a 'rough blob' surrounding the elephant may be similar to a ball, and that's all you need to keep track of where something is.

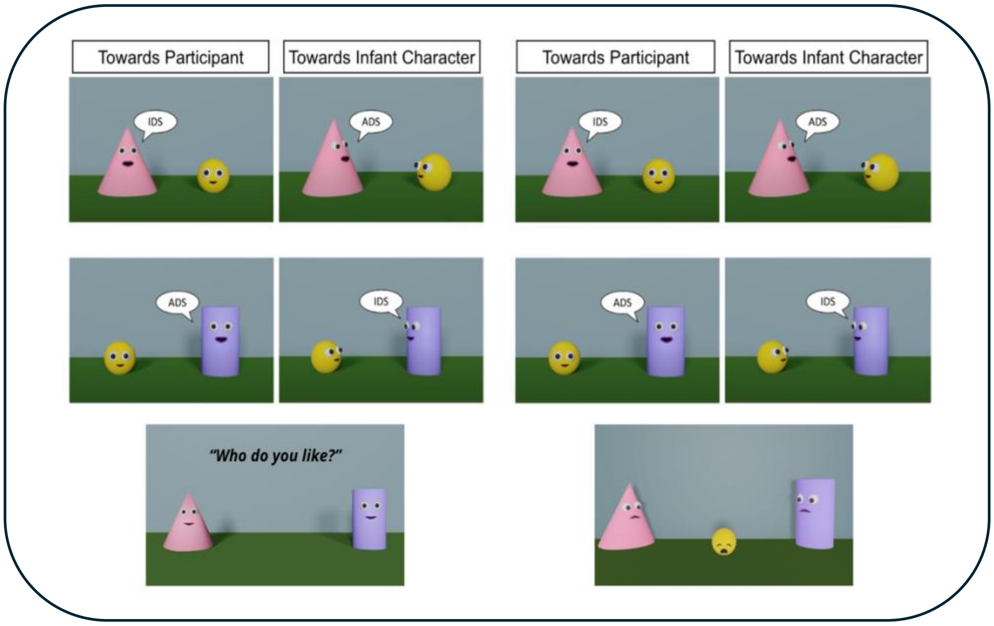
We are designing infant behavioral studies to examine this hypothesis, showing infants objects of different forms going behind screens, and seeing if their tracking and surprise is best predicted by this 'blob-like' representation. We have used the animation software Blender to create videos of moving objects in 3D to replicate the stimuli used in Xu and Carey (1996). We piloted a few participants and found our experiment pipeline to be working properly. We are currently in the process of formal data collection and designing stimuli for the second study.

Infants and toddlers' social inferences from interactions involving infant-directed and adult-directed speech

Ashley Leung (College Fellow); Emma Yu (Lab Manager), Wenxiu Wang (Research Assistant); Megan Richardson (Research Assistant); Ashley Thomas (Principal Investigator)

Many studies have found that infants prefer to listen to infant-directed speech (IDS), which is characterized by melodic intonation, exaggerated enunciation, and slower speed. The acoustic features of IDS may draw infants' attention to word boundaries and vowel sounds, aiding language acquisition. However, IDS may also serve a *social function*: it is used to engage and interact with babies and young children in social communication. In this study, we are interested in whether infants and toddlers use IDS as a cue for identifying close relationships.

Experiments are being conducted online over Zoom. For the infant portion of the study, infants between the ages of 5-6 months, 10-12 months, and 14-16 months watched videos of characters speaking to a baby character (using IDS or adult-directed speech [ADS]) on the screen, and their looking times were measured. For the toddler portion of the study, 3-year-olds were shown characters talking to someone (in IDS or ADS) behind a box, and asked to guess who was behind the box. On some trials, toddlers made social preference judgments on two characters who used either IDS or ADS towards the same target.



In our first infant pilot, we found that infants vary widely in who they prefer to look at after watching characters direct IDS towards themselves versus an onscreen baby character. Our current pilot asks whether infants expect a character to respond to the baby character's distress if they previously used IDS when talking to that baby character. Testing is ongoing for the toddler pilot, and we are excited to share findings from this study in the future!

Infant's Representation of Objects in Physical Tracking

Yichen Li (Graduate Student); Brandon Woo (Former Postdoctoral Researcher); Elizabeth Spelke (Co-Principal Investigator); Tomer Ullman (Co-Principal Investigator)

We are interested in how people represent objects differently when they're tracking them physically (say, to grab them) vs. to recognize them visually. This project examines the early development of this difference. Studies in cognitive development show that babies below 12 months do not use fine-grained form information to track objects (Xu & Carey, 1996; Xu, 2005). That is, when they see a toy elephant go behind a screen and a ball come out, they don't seem to think there are two different objects behind the screen. But infants can certainly tell the difference visually between a ball and an elephant (Wilcox et al., 2010, show infants are certainly able to individuate objects based on shape, pattern, and color). We interpret these findings as showing that infants may be relying on rough approximations for physical tracking: a 'rough blob' surrounding the elephant may be similar to a ball, and that's all you need to keep track of where something is. 14 We are designing infant behavioral studies to examine this hypothesis, showing infants objects of different forms going behind screens, and seeing if their tracking and surprise is best predicted by this 'blob-like' representation. We have used the animation software Blender to create videos of moving objects in 3D to replicate the stimuli used in Xu and Carey (1996). We piloted a few participants and found our experiment pipeline to be working properly. We are currently in the process of formal data collection and designing stimuli for the second study.