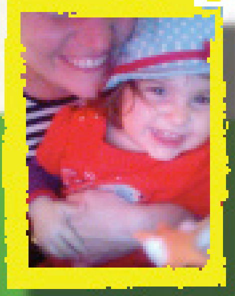
Lab For Developmental Studies At Harvard University

Newsletter 2011



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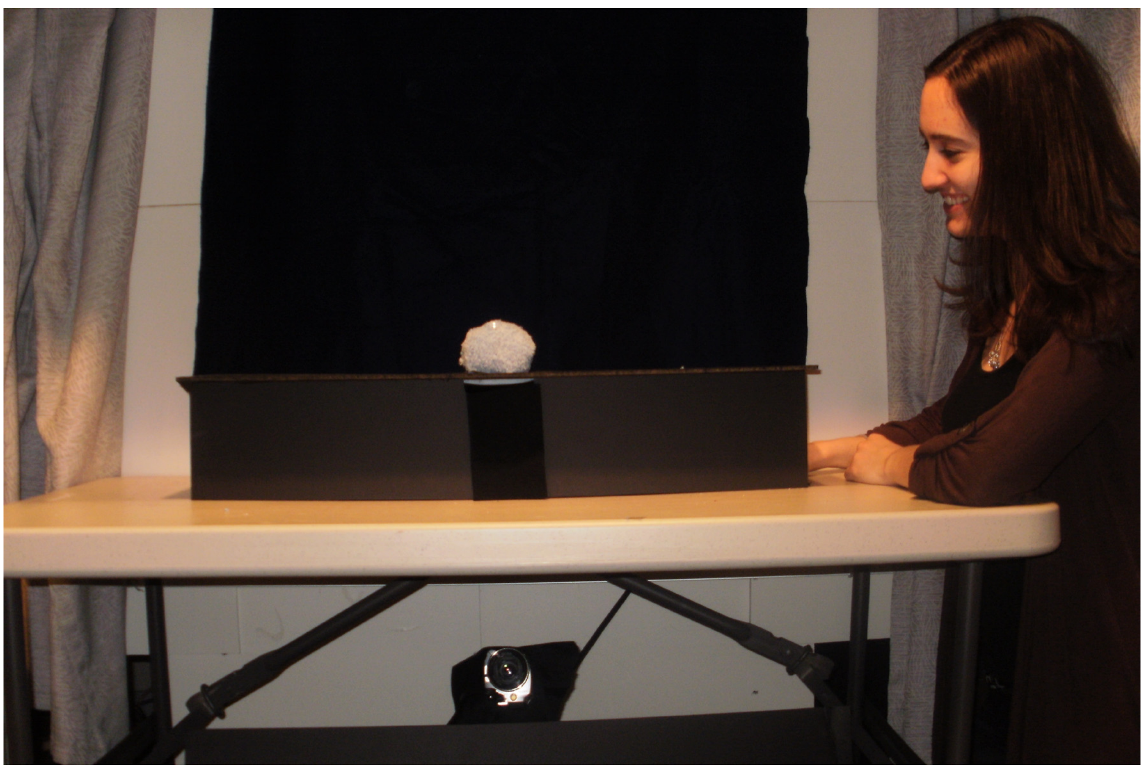
The Blob Study

Emily Bernier, Graduate Student

As adults, we effortlessly construe actions by those around us in terms of their goals. Dad reaches for a ball to pick it up; Mom goes to the fridge to open it. This kind of reasoning – thinking about the why of things, and assuming that people do things for a reason – appears in its simplest form in early infancy. 6-month-olds, for example, pay more attention to what a hand reaches for than to where it reaches; they look longer if the hand reaches for a new object, but not if the hand keeps reaching for the same object, regardless of where that object has moved to.

An interesting feature of goal-based reasoning in adults is that it is not restricted to thinking about the actions of people. We think the same way about the actions of animals, robots, cartoon characters, or even simple animated shapes. As it turns out, babies are similarly non-exclusive about who or what can have goals, and are willing to ascribe goals to all sorts of entities, as long as those entities show some kind of evidence of being animate.



So, what kind of evidence works? Past research has shown that if an object has a face, or can move on its own, or is interactive (beeping in response to a baby's noises and movements), babies are likely to think that it is animate. Studies have also suggested that one-year-old babies think an object is animate after seeing it interact with someone else. This finding is especially interesting, because we don't know very much about how young babies think about interactions they see between the people around them. Before babies understand language, what do they think is happening when people interact?

In the current study, we're looking at whether babies at two different ages (6 months and 13 months) will treat a new object (a small, fuzzy blob) as animate after seeing the object interact with an adult experimenter. After the blob has a short "conversation" with the adult, it moves repeatedly towards one of two goal objects: a cup, or a piece of plastic fruit. (Importantly, babies only see the blob once it has started moving – they never see it start moving on its own.) The cup and fruit then switch places. We measure babies' looking patterns when the blob either 1) moves towards the same object, now in a different place, or 2) moves towards a different object, in the same place. If babies are thinking about the blob's movements in terms of goals, their looking patterns should change when the blob changes goals; we would expect longer looking times, indicating surprise, or longer processing time.

We're still collecting data, but right now, it looks like the 6-month-olds and 13-month-olds are responding differently. The 13-month-olds seem to be looking longer when the blob changes goals (suggesting that they're using the initial "conversation" to classify the blob as an animate agent), but the 6-month-olds don't seem to care at all! We'll see if this pattern continues, and will let you know in the next newsletter.

Avoiding Tempting Mistinterpretations

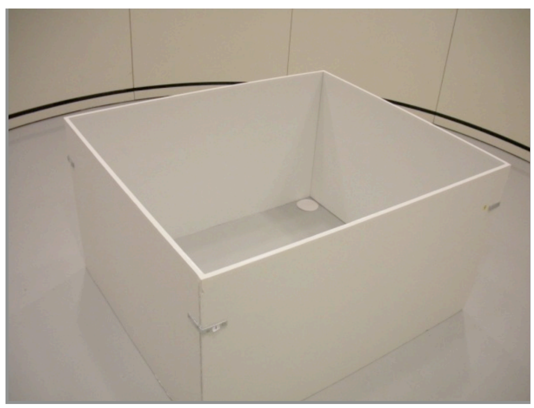
Manizeh Khan, Graduate Student

As children go from energetic preschoolers to sophisticated middle-schoolers, many many things change. In a set of studies that were run both in the lab and at the Boston Children's Museum, we were interested in two of these changes, and in looking at how they might be related to each other. One development that's clear to anyone who's interacted with children from this age range is that older children show more self-control. They are better able to avoid doing what they shouldn't do, avoid saying what they shouldn't say. Another parallel change occurs in the domain of language. Preschoolers make some systematic mistakes in understanding what other people say, even though they sometimes say similar sentences themselves, that older children do not. Are the developments in language comprehension due to the development of inhibitory control? Perhaps young children are so swayed by initial misinterpretations of sentences that they cannot inhibit them, even when it's clear that they've misunderstood. To ask this question, we looked at 6-10 year old children and wondered if we could, ever so briefly, make them act like 3-5 year old children again. Children at the Museum stopped by our testing room and completed two short computer tasks. Both of these tasks required a lot of inhibitory control. In the first part, children pressed the arrow key that matched an arrow presented in the middle of the screen, but sometimes there were four other arrows on screen that were pointing in the opposite direction, and the child had to resist pressing that key instead. In the second part, children had to press button that matched colored squares on the screen, resisting the temptation to hit the button that was closer to the square and seeking out the color-match instead. Our idea was that inhibition is similar to a muscle – if you use it a lot it gets tired. And that is in fact what we see. After doing one task that required a lot of inhibition, children had less leftover for the second task and started to make more mistakes or respond more slowly; that is, they looked a lot more like their preschool-age counterparts. Of course, this effect was very short-lived and they went back to being their sophisticated grade-school selves before they even left the room. Currently in the lab we are looking at how this task affects language processing in particular. After playing the arrows game, do older children make mistakes in understanding sentences, the same kinds of mistakes that 3-5 year olds do?

Implicit Geometry Knowledge

Yi Huang, Visiting Graduate Student

Geometry was thought by the ancient philosophers to be one of the purest forms of human knowledge. In our previous studies, we have found that young children can use distances and sense relations within the 3D environmental terrain, but they do not use angle (i.e., the measure of the corners at which two surfaces meet) to remember locations and reorient themselves. In this current study, we investigate children's sensitivity to 3D distance information. We designed three small, slightly rectangular rooms with ratios of 36 inches by 42 inches, 36 inches by 40.5 inches, and 36 inches by 39 inches. In each rectangular room, children watched the researcher hide a sticker in one of the four corners. Then, we had them close their eyes and spin around in a circle to become disoriented. Finally, we asked them to find the sticker! We've found that 3.5-5.5 year-old children can successfully find the sticker in the 36 inch by 42 inch rectangular room, but not in the other two, although the difference between the wall lengths of the 36 inch by 42 inch room is still very tiny.



Furthermore we want to know whether children can use a 2D image that corresponds to the previously seen 3D environment. To do this, we presented two round pictures to children after they finished the sticker hiding game. One picture had a square in the center, and the other had a rectangle with the same ratio as the previously seen rectangular room. Both the square and the rectangle had the same ratio as the previously seen rectangular room. We asked children which one they thought was the picture of the room that they were just in. We found that children consistently chose the picture of the square, as the picture of the room that they were just in. This finding suggests that children at this age cannot explicitly represent the rectangular room to be a 2D rectangular shape, and they think the 3D room that is slightly rectangular is actually square in shape. However, they can still successfully navigate the rectangular room during the sticker finding game, using only the ratio information. Children do not form the 2D shape in their minds to aid them in completing the 3D navigation task!

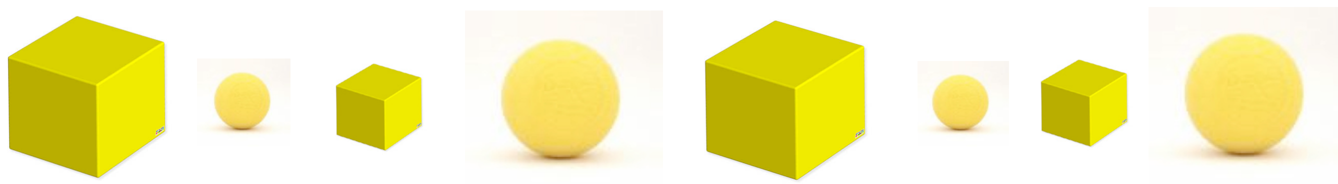
Thinking in Words

Manizeh Khan & Amy Geojo, Graduate Students; Shan Wang, Thesis Student

As adults, we often have the sensation of speaking silently in our heads when we're thinking, an inner dialogue narrating the contents of our minds. To what extent does this intimate connection between language and thought exist in young children? On the one hand, you might suspect that the two are so intricately intertwined that they could not possibly be decoupled in children. On the other, it is possible that this link is forged over many years of linguistic experience, years of the labels for various concepts being rehearsed over and over again, becoming more and more easily retrieved. To investigate this question, we asked two year olds and four year olds to simply look at pictures. Children sat on their parents' laps and watched a stream of pictures projected onto a screen, some were labeled out loud, some presented with just an auditory attention-getter, and some presented silently. Sometimes pictures that were presented sequentially were related, but in a way that would only be detected if the child had independently thought of the name of one the silent pictures. For example, a picture of a cup and a picture of a cat would seem to have nothing in common, unless the child had thought of the words "cup" and "cat", which share the "c" sound. We later coded videos of children in the task and looked at how long they looked at the various pictures. We found that two year olds spent less time looking at a picture if it was related to the name of the picture that had been presented immediately beforehand, even though this name was not said out loud to the child. This means that the two year olds were spontaneously thinking of words for objects as they were seeing them, even though they weren't talking about them. We are still working on testing four year olds, but so far they also show this pattern of internally naming the pictures that they see. So, much like adults, young children's inner thoughts are full of words.

Sets in Working Memory

Arin Tuerk, Graduate Student;



We are constantly bombarded by new gimmicks promising to "improve our memory," and human interest stories about individuals with either incredibly long or devastatingly short memory spans. People have long been intrigued by the parameters of short-term, or "working" memory, and the ways in which we can expand our mnemonic capacity beyond these limits.

We know that adults can hold only 3-4 "units" in working memory at once, and that these units can be individual items, or "chunks" of 3-4 associated individuals. We also know that for adults, large sets of similar items can also function as units in memory, but that we can only store about 3 such sets in working memory at any given time. We have been exploring this capacity limitation and found that although adults can only remember about 3 independent sets (such as a set of cotton balls, a set of poker chips and a set of starburst candies) their memory capacity for sets of items that overlap in features (such as 4 sets of blue and red circles and triangles) is much less limited. In fact, adults can remember information about 16 sets, when they share features along color, shape, size and topology dimensions!

The goal of this set of studies is to see how whether children can also advantageously organize the contents of working memory, and thereby increase the total amount of information they can remember. In our first study, we replicated some adult findings with 3, 4 and 5 year olds and found that just like adults, children can only keep track of up to 3 sets of non-overlapping items. We then created 4 overlapping sets out of large and small blocks and balls to see whether, like adults, children could remember information about more than 3 sets by capitalizing on the shared features across these sets. . Is this ability to reorganize and encode information effectively a uniquely adult trait? Or is this advantageous mnemonic process available throughout the lifespan?

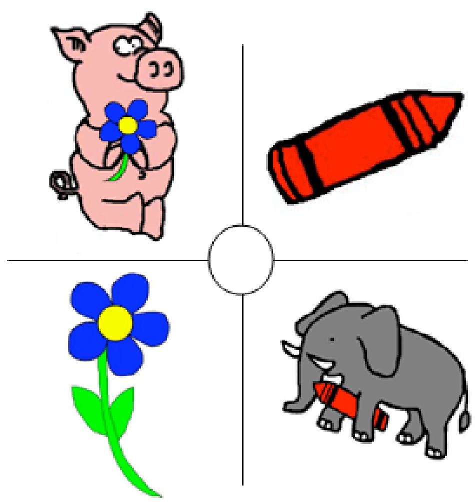
To explore these questions, we showed children between the ages of 3 and 7 years items of 4 different types. Importantly, these items overlapped in features (i.e. a big block, a small block, a big ball and a small ball, such that a big block is a member of the "big things" set and also a member of the "block things" set.) As each item is dropped into a bucket, the child labels it either along the shape dimension (block, ball, ball, block etc) or along the size dimension (big, small,small etc). The child is then asked which bucket has more items of a given dimension (i.e. shape dimension: "which bucket has more blocks?" or size dimension: "which bucket has more big things?") We find that children ages 3-5 are only accurate if the dimension they have been labeling along is congruent with the dimension they've been asked about (i.e. they've been labeling objects as blocks or balls and then are asked which bucket has more blocks in it) whereas 6-7 year olds are successful at answering questions along both the congruent and incongruent dimensions! This suggests that rather than developing with age, children's memory system is already set up to handle some of the problems that the real world presents! This surprising finding speaks to the incredible pattern detecting ability we often find in young children. It seems that from early in life children are picking up on regularities in their environment, allowing them to learn and remember as much as they can about the ever-changing world around them. What types of objects can be grouped into a set? What exactly are children remembering about the individual items they saw? Future studies will ask just these questions, so stay tuned!

Young Children's Use of the Visual Scene

Carlyn Friedberg, Researcher

In this third version of our three-part study, we investigate young children's use of visual and verbal information when processing spoken language. Children as young as four and five use similar, extremely fast processes as adults when interpreting an instruction like "scratch the pig with the flower". This sentence can mean use the flower to scratch the pig OR scratch the pig that is holding the flower. Like adults, four- and five-year-old children rapidly use intonation, knowledge about what different verbs mean, and the plausibility of the sentence when figuring out what these sentences could mean. However, while adults may also integrate the visual scene into their processing, previous research has shown children are not as sensitive to the visual scene until age seven or eight.

The use of visual scene, or referential context, while listening to such a sentence can yield different interpretations depending on how many pigs are in the scene. Imagine the following scene: a pig holding a flower, an elephant holding a crayon, a large flower, and a large crayon. With one pig present, adult listeners may take the ambiguous "with" phrase as an instrument for the verb and interpret the sentence as use the flower to scratch the pig, because no additional information is required to identify the pig. Now imagine two pigs: a pig holding a flower, a pig holding a crayon, a large flower, and a large crayon. With two pigs, adult listeners may take the ambiguous "with" phrase as more information about one of the pigs, and interpret the sentence as scratch the pig that is holding the flower (rather than the one holding the crayon). We want to figure out how and why this sensitivity to referential context changes over the course of young language learners' development.



In this three-part study, we investigate whether five-year-old children can learn to use the visual scene when interpreting ambiguous instructions. Their ability to use and generalize this cue will help us understand how young children quickly determine the grammatical structure of spoken language. Children who participate in this study come into the lab on three separate occasions. For the first session, children participate in a pre-test and a training session with two experimenters. For the second session, children participate in more training followed by a post-test. During the third session, we administer a short memory game and a standardized vocabulary test.

During the pre- and post-tests, we record children's eye-movements as they look at a set of toys and listen to pre-recorded ambiguous instructions. As the sentence unfolds, eye-movements give us an idea of how they are processing the sentence and what they expect to hear during real time. We also record their actions, or responses to the instructions, during each session. The ambiguous instructions children hear are things like "scratch the pig with the flower" when there is one pig or two pigs present. Both the modifier and instrument interpretations are possible during the pre- and post-test. To teach children that the visual scene is useful in resolving ambiguous instructions, they watch the experimenters follow unambiguous instructions; that is, the toys before the experimenter and the accompanying sentence can only resolve in one interpretation. The goal of training is to show children that the visual scene is useful; that modification is sometimes necessary; and that the "with" phrase can provide more information to a listener. Children also get to participate in this unambiguous session. Our hypothesis is that this training may lead to a different interpretation of ambiguous sentences, one that relies more on visual information, during the post-test.

We compare children's eye-movements and actions before and after the training session to see if they can learn to more consistently utilize visual cues when processing ambiguous language.

Data collection continues. So far, children's actions across the pre- and post-tests reveal that they may be able to distinguish between one-referent and two-referent contexts during spoken language comprehension. This change is evidence that using visual information during sentence processing is not as difficult for these children as we've thought.

Thank you for your participation and time! Stay tuned!

The Process of Elimination

Shilpa Mody, Graduate Student

What kinds of general-purpose reasoning skills do infants have? How do those skills change and develop as the child grows older? In this study, we asked whether infants at different ages could use one particular reasoning tool: the process of elimination.

Adults use the process of elimination in everyday settings. For example, if you know you left your cellphone either in your bag or on the counter, and you've already searched in your bag, you can assume that it's on the counter without having to check. To reason like this, you have to be able to consider multiple alternatives, then update your beliefs with new information about where your cellphone is not, and finally combine all this to infer where your cellphone must be.

We investigated this kind of reasoning in infants by playing a searching game. They watched while we hid a toy in one of two buckets, but couldn't tell which one we'd put it in. Next, we showed them that one of the buckets was empty. Then we asked them to look for the toy. Using the process of elimination, they should reason that the toy is in one of the two buckets, but it's not in the empty one, so it must be in the other one. 23-month-olds picked the correct bucket about 80% of the time, suggesting that they're successfully using the process of elimination. Data collection for 17-month-olds is still ongoing.

Going forward, we're interested in looking at even younger infants to see when this ability first shows up. Thanks to all the families that participated!

Who's He?
Learning to Use Pronouns

Rebecca Nappa, Post-doc; Nicole Grifka, Stephanie Afflito, Research Assistants

Ever wonder how you figure out what pronouns – like, "he," "she," and "it" – refer to when someone's telling you a story? Probably not! That's one thing that's so amazing about language, we produce and understand it so effortlessly. But there are actually complicated processes involved in understanding even the simplest chunks of language, and kids have to learn how to put all those complicated processes together to understand what adults are saying.

In a series of experiments, we've been investigating how children with and without autism learn to remember who's being talked about, so that pronoun resolution is as effortless for them as it is for us. We give them short stories with accompanying pictures, like "Fred went to work with Barney this morning. He had to get up very early!"

Then we ask them who had to get up early (to see how they interpreted the pronoun) and track their eye movements, so we can see those interpretations unfold over time (did they look at Fred first? Barney? How long did they take to figure it out?).

Turns out 5 year olds make the same interpretations as adults (we usually think "he" refers to Fred, since he was the subject of the last sentence), but they take a lot longer to look at him, and make that decision. Children with autism, however, couldn't figure out who that pronoun referred to at all (they were 50/50 when they had to choose Fred or Barney). Oddly enough, though, their eye movements showed that they looked at Fred very quickly (faster than the typical children), even when they ultimately decided that "he" meant Barney. These puzzling results are the subject of ongoing studies to figure out how the thought process differs in children with autism, and why they struggle to figure out who "he" is.

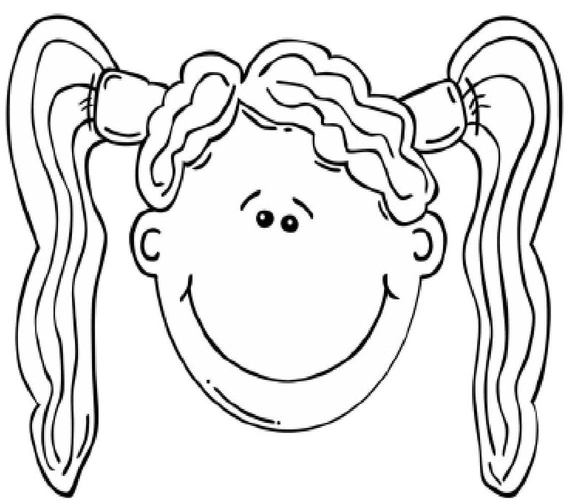
Social Categorization: Gender

Denetrias Charlemagne, Thesis Student

In this study, we wanted to learn about how infants are able to understand categories of people. Particularly, we wanted to know whether infants were able to categorize people based on gender, and the experiment explored how language may aid infants in forming such categories. This experiment was a follow up to a prior finding in the laboratory, which illustrated that noun labels (even nonsense ones such as “blicket”) are needed to facilitate categorization of faces based on race and/or skin color. However, although this earlier research demonstrates that noun labels may be relevant in the social categorization of race, developmental literature on gender suggests that infants are able to differentiate between and categorize male and female faces without a label.

During the study, infants watched as pictures of individual faces appeared a screen. Infants were shown 9 faces. All these faces belonged to the same gender. In one condition infants heard the utterance, “look at that blicket!” 6 out of the 9 times the faces were displayed. In the second condition, infants saw all 9 faces, but did not hear a sound. To test if infants had formed the male and female categories, infants were then shown two new faces side-by-side. One face was male and the other was female. If infants categorized the faces base on gender, we expect that in these trials they will look longer to the face from the new category (e.g. if they were shown all female faces, they will longer at male and vice versa).

We have found that infants do not rely on noun labels to facilitate gender categorization and were able to categorize faces in both conditions. Thus, unlike race, gender appears to be a more salient category for infants, who were able to represent these categories with or without the aid of noun labels.

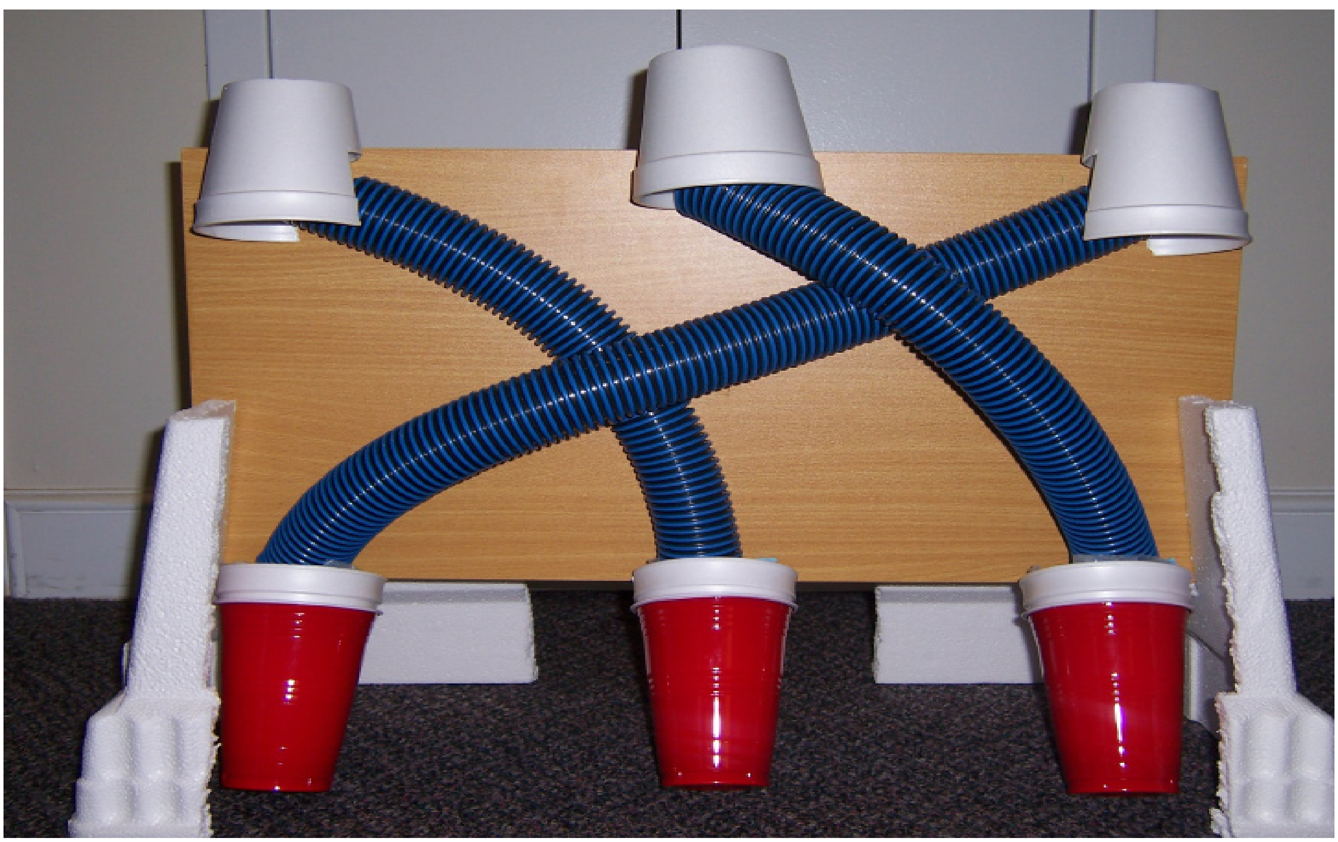


Gravity Error and Executive Function

Igor Bascandziev & Lindsey Powell, Graduate Students;
Kristiana Laugen & Michelle Bang, Research Assistants

We are interested in how children learn about the world. Although some kinds of learning come easily to children, occasionally the world presents them with a situation that is difficult to understand because it goes against their intuitions and contradicts previous experience. In these cases, it often takes time and effort for children to change the way they view the world.

One such example involves children's understanding of falling objects. Around the age of 3, children have a bias – we'll call it the gravity bias – that leads them to expect objects to fall straight down, even when there's something in the way. For example, if you drop a ball into a tube that leads off to the left of where it started and then give children a chance to search either directly beneath the start of the tube or at the tube's end, 3-year-olds will often search directly beneath the start of the tube, as though they still expect the ball to have fallen straight down. They often continue to make this error, even after being shown several times that the ball ended up at the end of the tube. Recent research has demonstrated, however, that some kinds of training can help children around the age of 3½ years to search in the correct location. Both explaining to children how the tube traps and redirects the ball and giving them a strategy for following the tube to its end help some children to spontaneously search for the ball in the correct location.



This training isn't always effective, however, and for younger 3-year-olds it doesn't seem to help at all. Our research is aimed at identifying the mental skills that allow children to make use of this kind of training. In particular, we are interested in discovering if skills called "executive function," are important when children are trying to change and improve their theories about how the world works. Executive function is a set of mental skills that allow us to think flexibly, inhibit some thoughts and impulses, and hold several pieces of information in working memory at a given moment in time.

To explore this question, we measured children's performance on the tubes task. We first assessed children's performance on this task. Then, we provided each child with a short training that explained to them the role that the tubes play in guiding the trajectory of the ball. After the training, we once again assessed children's performance on the tubes task. This procedure allowed us to identify the children who benefitted from the provided instruction. In addition to the tubes task, we also administered other tasks that measured children's inhibitory control and working memory. Thus, by obtaining these measures, we could see if children's inhibitory control and working memory are correlated with their ability to improve on the tubes task. We also administered verbal and performance IQ measures, so we could statistically keep these variables constant.

We are still collecting data for this project, but we're already starting to see a very interesting result. Children with low delay inhibitory control benefited the most from the instruction. In other words, children who found it difficult to inhibit (stop) their impulses, were the children who improved the most on the tubes task after hearing testimony about the role of the tubes. One plausible interpretation of this result is that such children when confronted with a task like the tubes task go with their first impulse and do not devote time to reasoning about the problem. Hence, these children benefit the most from pedagogical interventions that oblige them to allocate time to thinking about the problem.

Learning from Others

Sunae Kim, Post-doctoral Fellow

Most of what we know comes not from our direct experience, but from information that is communicated by others. Children, especially, are dependent on others around them for knowledge. But how do we decide among informants who make different claims about the world? Do we believe accurate claims? Do we believe claims by others who have more social connections?

In a series of studies, 4-year-old children watched an animated story on the computer where two different characters provide conflicting reports about the hidden contents of a container (e.g., "There is a hat in the box" vs. "There is a scarf in the box"), and they were asked to endorse one of the conflicting reports (e.g., "What do you think is inside? Do you think there is a hat like the first character said, or a scarf like the second character said?"). The characters differed on various dimensions such as whether they looked into the box, whether they had friends, whether they received accurate or inaccurate information from their friends, and whether others offered a converging report, etc. Preliminary results show that children are mainly interested in gaining accurate knowledge from others.

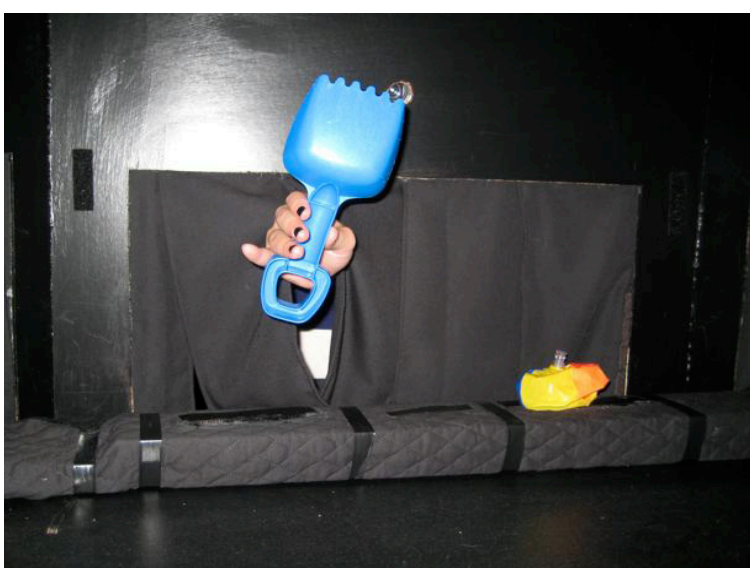
The Development of Logic

Roman Feiman, Graduate Student

Do infants know logic?

What do infants understand about logic? Can 12-month-old infants understand a very abstract concept like "not"? Imagine what is required to understand the difference between "I am not going to the store" and "I am going to the store", or "this is not a book" and "this is a book". We tried asking whether infants can understand a concept like "not" by seeing if they could learn a rule using that concept. Infants in this study heard a whole lot of different sounds, while watching two objects on a stage. One sound predicted the right object floating up in the air and dancing, while all of the other sounds predicted the left object doing the same thing. We predicted that if infants learned what each sound predicts separately, they should look in the correct direction (left or right) after every familiar sound played, but they should have no predictions about a new sound that they hadn't heard yet. If, on the other hand, infants formed rules like "That sound predicts something interesting happening on the right side" and "Everything that's not that sound, predicts something interesting happening on the left", they should predict that because a new sound they'd never heard isn't the same as that first right-predicting sound, it should be followed by something interesting happening on the left -- just like all the other sounds.

Unfortunately, we ended up not being able to test this prediction directly, because what we found is that infants had trouble learning any of the rules at all! We do know from other studies that, in general, 12-month-olds can learn that a sound predicts something interesting happening on either the left or the right. However, those studies were done with infants looking at a screen, not a live stage, and the "something interesting" was a flashing new shape that was changing sizes. In between them hearing different sounds, those shapes would disappear. We don't know if any of these differences between those studies and ours might have made a difference, but we're planning on finding out. We're starting a new set of studies, using a method that's more similar to the rule-learning studies that have succeeded before in other labs. Once we have an experiment where we can show that infants consistently learn at least two rules, we can resume asking whether they can learn the two rules -- "that one sound means right" and "not that one sound means left".



Does logic underlie language?

One of the most amazing things about language is that it is productive. It allows us to take concepts we know -- words we've learned -- and assemble them together in new ways to express thoughts we've never expressed before. I bet you've never thought or said, "If there was a blue bear on Neptune, he would probably be hungry". But you have no trouble understanding it and I had no trouble writing it. The project we have been working on looks at what underlies this productive ability. It turns out that one answer might be a formal logical system.

Some sentences in language are ambiguous in a systematic way. These sentences have two quantifier words (words like "some", "every", "most", and so on), or one quantifier and a negation (the word "not"). Take, for example, the sentence, "Every horse didn't jump over the fence". This sentence could mean that every horse has a particular property -- that of not jumping over the fence -- meaning that none of the horses jumped. Or it could mean that a particular state of affairs is not the case -- it's not the case that all of the horses jumped -- meaning some or none of them did. It turns out that this ambiguity is well characterized by a type of formal logic (called "first order", or "predicate" logic), where logical operators (which include quantifiers and the word "not") can stand in different relations to each other in a way that produces exactly both meanings of this ambiguous sentence. Is this a coincidence? Or is it possible that what underlies the way we combine words like quantifiers and "not" with ideas like horses and jumping over the fence is a lot like the structure of this formal logical system?

We investigate this question by telling 4-year-old kids stories in which the plot is consistent with only one meaning of an ambiguous sentence -- for example, where two out of three horses did in fact jump over the fence. They then hear the ambiguous sentence spoken by a puppet -- "Every horse didn't jump over the fence" -- and have to decide if the puppet is right or wrong. Since the sentence is ambiguous, there is no right or wrong answer. Instead, how the kids judge what the puppet said lets us know what kids thoughts the ambiguous sentence meant. Did they think it meant some of the horses might've jumped, in which case the puppet was right, or that none of them jumped, in which case the puppet had to be wrong? It turns out that what kids answer depends on what happens in the story first. If before two out of three horses tried jumping over the fence, all of them successfully jumped over a log, kids are more likely to interpret the ambiguous sentence later on to mean that some of the horses jumped. If they just thought about jumping over the log, but decided not to, kids are more likely to interpret the ambiguous sentence about the fence to mean that none of them jumped.

What we do next is change the story. We reasoned that if there's something in kids' heads that corresponds to the logical structure of the sentence, then there's a chance that their answers will stay the same across different stories -- when we tell them about two out of three girls collecting starfish, for example, and ask them to evaluate the ambiguous sentence, "Every girl caught a starfish". Furthermore, we change that initial component, too. After a few stories where all three entities in the stories succeeded before two out of three doing something else, we now have none of the three succeeding on a few subsequent stories. What we've found is that kids continue to give the same answers that they were giving initially -- kids who were understanding the sentence to mean, "some of the horses jumped", understand the next story's sentence to mean, "some of the girls caught a starfish", continuing to disambiguate these sentences the same way across different story contents, and even once the story component of previous success. We want to argue that what underlies this finding is that kids are continuing to use the same abstract logical structure across stories, swapping in the contents of the stories as appropriate. This finding is still preliminary, and a few other explanations exist, but we are now working on ruling those out, and are very excited to see how these studies work out!

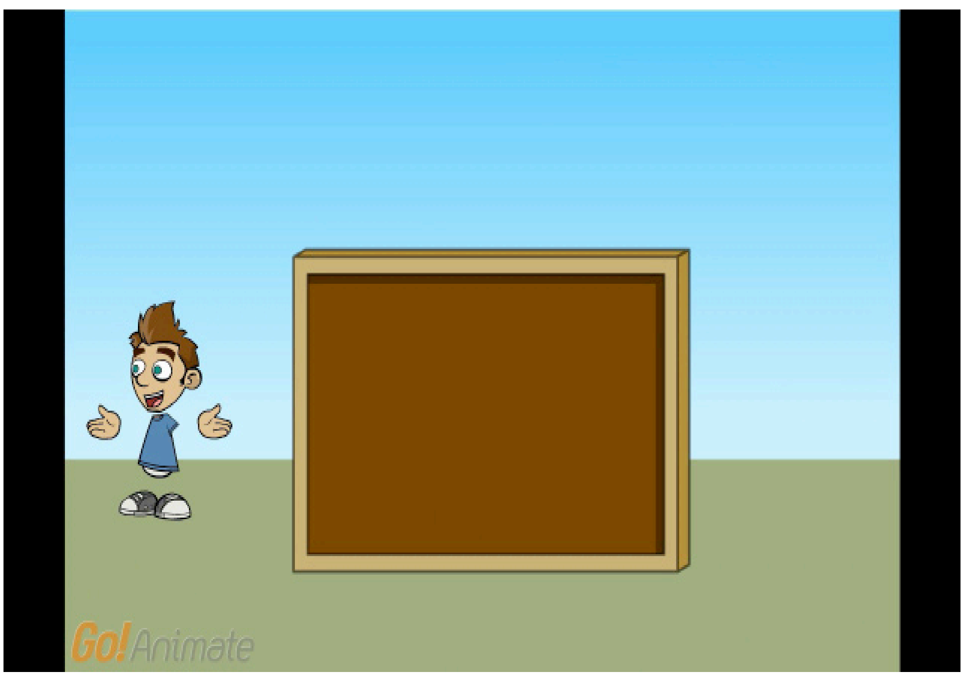
Detecting Identity

Jean-Remy Hochmann, Post-doctoral Fellow

Individuation Study

Infants very early make the difference between human beings and other types of objects or animals. Even newborns use the configuration of eyes, mouth and nose to recognize a human face. But how do they recognize a specific person, and discriminate it from other persons? In this study, we ask whether infants preferentially use different perceptual cues to individuate human beings, such as skin color, clothes, voice and spoken language.

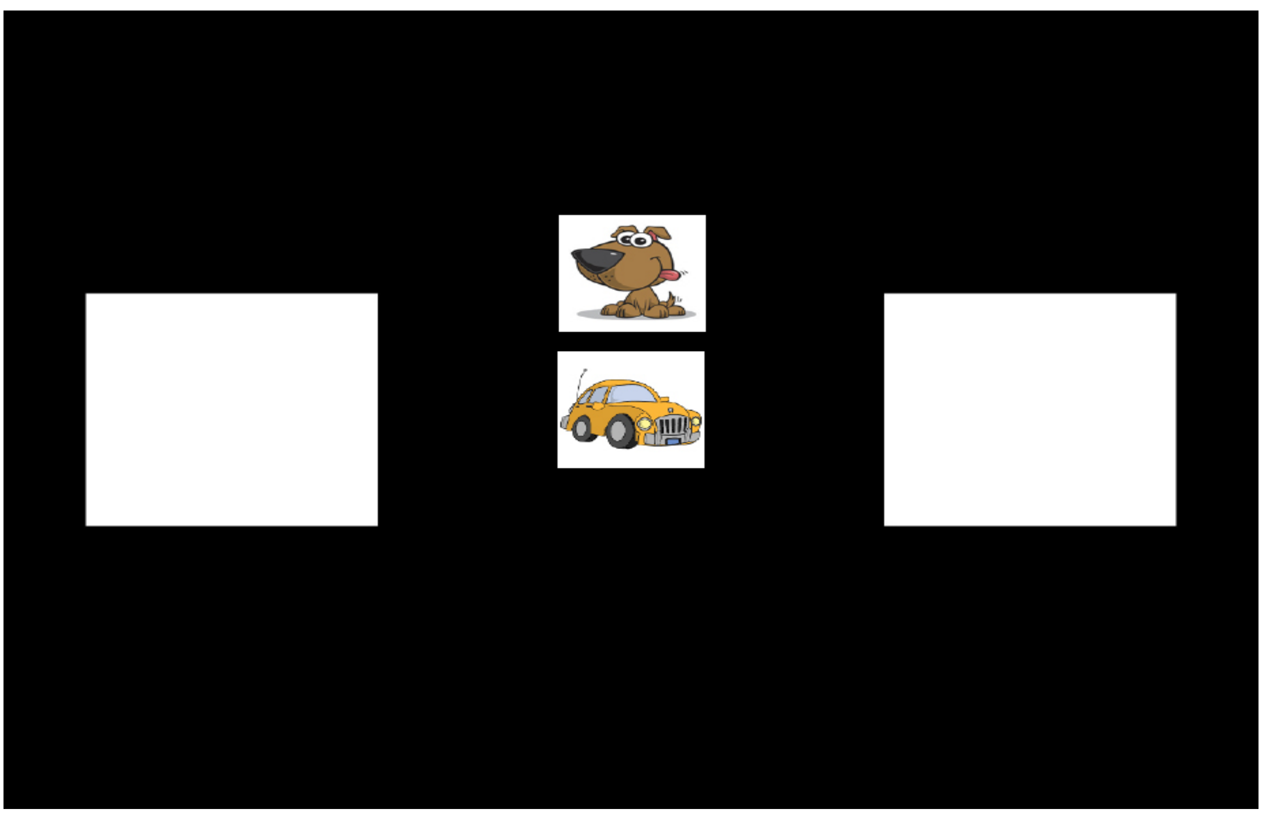
During this study children sat in their parents' lap, facing a screen. This screen was equipped with the same eye tracker as described in the previous study. On each trial, children saw a short animated movie presenting two characters coming out from behind a wall. The two characters may differ from each other in one or several features: skin color, clothes, voice, spoken language. Once both characters are back behind the wall, the wall falls revealing both characters or only one of them. We ask whether infants expected two characters behind the wall, and are surprised if only one character remains (We can assess infant expectation by measuring how long they look at what is on the screen – longer looks mean they are surprised!) If they are surprised, this would show that they used the perceptual differences between the characters to individuate them. We'll keep you updated as to what we find, and thanks for participating!



Same Different Study

Humans, like all animal species, are born with certain concepts, such as the idea of objects, animacy and small numbers. But only humans develop complex concepts such as microchip or freedom of speech. Humans, indeed, have the unique ability to combine known concepts to build a novel concept. For example, they can combine the concept of “not” and “brown”, to obtain the concept of “not brown”. Our study seeks to understand at what age and in what circumstances infants show this ability, called compositionality. Precisely, we ask whether infants can form the concept of “different” as the negation of the concept “same”. To look at this, we are testing 12-20 month old children who have not yet acquired, or are beginning to acquire, their native language.

During this study, children sat on their parents’ lap, facing a screen. This screen is equipped with an eye-tracker that automatically detects the eyes, and allows us to precisely monitor the position of children’s gaze on the screen. On each trial, children heard a word or saw two geometrical shapes, after which a puppet appeared either on the right or on the left of the screen. The puppet appeared in a given location if the two syllables constituting the word, or the two geometrical shapes were identical, and in another location if they were different. There were 36 such trials. By monitoring the location of their gaze on the screen, we ask whether children can learn to predict the location of the puppet’s appearance We are still in initial phases of this project, and hope to bring you findings in future newsletters!



Children's Memory for Counterintuitive Concepts

Konika Banerjee, Lab Coordinator

What do a talking tree, an invisible rabbit, and an angry hammer all have in common? They each violate our psychological, physical, and biological expectations about how objects and agents in the natural world typically behave. In other words, these concepts are all counterintuitive. When counterintuitive concepts violate just a few of our expectations but conform to all others, they are called minimally counterintuitive. One interesting characteristic of minimally counterintuitive concepts is that they are highly memorable. In fact, research with adults has shown that minimally counterintuitive concepts tend to stick out in our memory better than entirely intuitive concepts that fit our expectations perfectly. For example, we are more likely to remember a story about a plant that can turn invisible at will than a plant that always stays rooted into the soil.

We know that adults remember minimally counterintuitive concepts better than intuitive concepts, but do children do the same thing? One thing we know for sure is that children are highly familiar with counterintuitive concepts such as Santa Claus, the Tooth Fairy, and the magical creatures and characters of fairytales and fantasy books that are all common features of children's cultural narratives and traditions.

In this study, we read children a story about two kids who explore a new neighborhood and encounter a number of objects along the way. Six of the objects were minimally counterintuitive (MCI) and six were entirely intuitive (INT). For example, the children came across a crying mailbox (MCI) in one part of the story and a rusty stop sign (INT) in another part. Children were asked to listen to the story and to try to imagine the events in their heads, because they would be asked questions about it later on.

Next, children completed a short computer task in which they were asked to pick which two of three angles shown on the screen looked the most similar to each other. This task was intended to temporarily distract the children from the story they had just heard. Afterward, they were asked to think back to the story and to recall as many details from the story as they could remember. Their answers were recorded and coded so that we could determine whether children recalled the MCI and INT concepts at different rates.

We were also interested in whether children recalled the two types of concepts differently after a delay of one week. To study this, we called families at their homes one week after their lab visit and asked children to recall everything they could remember about the story they had heard a week before. Children did not know that they would be contacted for this delayed recall task, so they had not rehearsed the story during the week since their lab visit.

The study results show that children, like adults, recall MCI concepts better than INT concepts, both during the immediate recall task in the lab and also one week later. Children consistently recalled the six objects paired with a MCI description better than the six objects paired with an INT description. They also remembered the MCI concepts in greater detail than the INT concepts both immediately and after a delay. These findings suggest that minimally counterintuitive concepts enjoy a memory advantage not only for adults, but for children as well. Thanks so much for your participation in this study!

Children's Language Processing

Joshua Hartshorne, Graduate Student

While many studies have looked at how adult brains process sentences, less is known about how a child's brain process sentences. Typical neuroimaging studies present challenges for children, because the methodologies require participants to sit still for long periods of time and usually involving reading -- two activities that are difficult for very young children. This year we began a preliminary study aimed at adapting electroencephalography (the study of brain waves) for 4-5 year-old children. Children were presented with sentences with pronouns that were either of the correct or incorrect gender:

Sally went to the store. She bought an ice cream cone.
vs.
Sally went to the store. He bought an ice cream cone.

We used a specialized hat containing electrodes to record the children's brain waves during the study. We will compare brain waves that occur for correct or incorrect pronouns in order to better understand how young children interpret pronouns.

The study is ongoing and results are still some time off. However, we have learned a great deal about making such experiments kid-friendly. Because young children cannot read, we played them audio recordings of the sentences. This requires carefully controlling the exact timing of the words, which was a challenge. We also devised many techniques to help children sit still, some of which are as simple as finding a comfortable chair of the right size, plus a foot rest. With any luck, this work will pay off and we will have a new method that we can use to probe children's growing understanding of language.

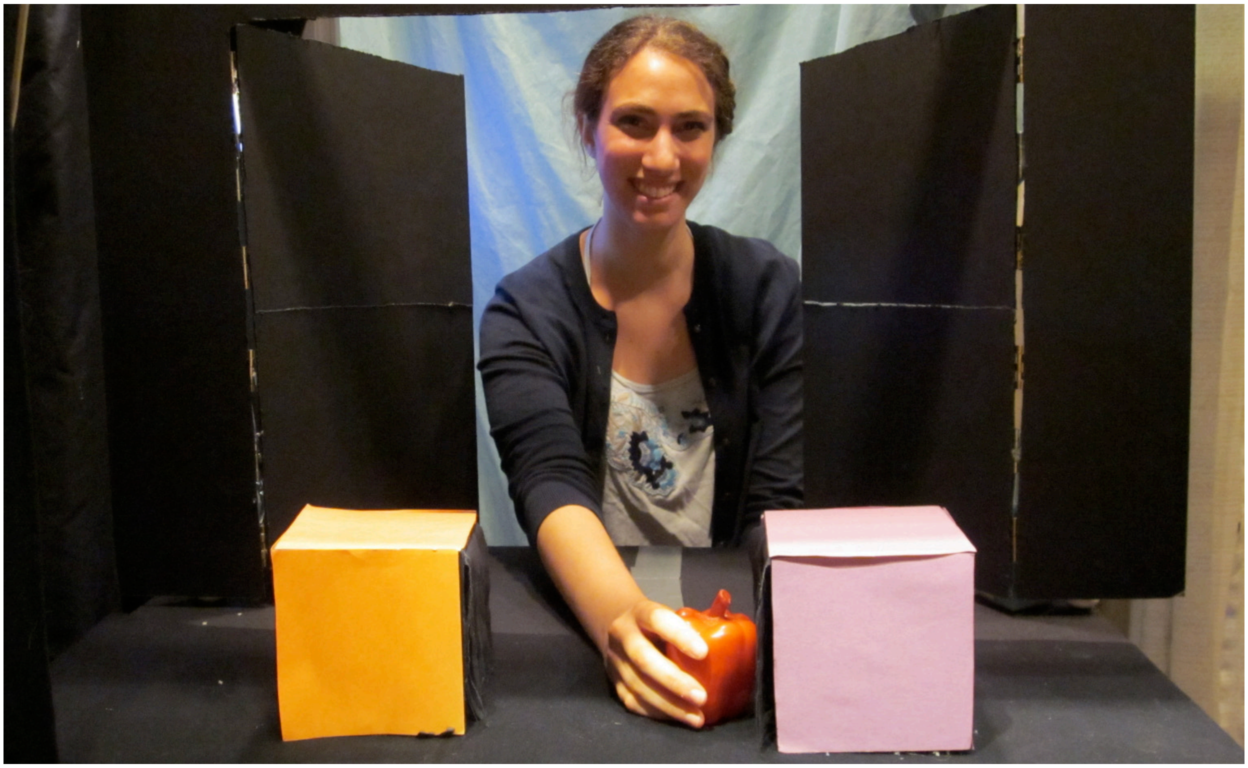
Happy Sharing

Lauren Kleutsch, Lab Coordinator; Jackie Coleman, Researcher

In this study, we are interested in determining whether children's decisions about sharing are influenced by other people's emotions about their sharing act. Do they share more when they know it will make the other person happy? Or do they just share according to a rule that suggests that each person should get the same amount? During study, the child watches an experimenter react to one toy with positive emotion and react to another toy with neutral affect. Both of the toys require resources in order to work (for example, balls to roll down a ramp or stickers to put into a book). Children have the opportunity to play with these games as well (and they really love it!), and we are interested to see whether they are still willing to share when the other person is excited about the game as well.

Can Toddlers Read Your Mind?

Lindsey Powell, Graduate Student



In the everyday world we spend a lot of time interacting with inanimate objects, and this is made easier by the fact that we have some rules we can use to figure out what those objects will do. We know that if we set our keys on the counter they won't drift away on their own, that the cat hair will be effectively sucked up by the air heading in to the vacuum cleaner, and that, to our chagrin, when we drop the carton of milk it will fall to the floor and spill.

These simple, physical rules make interacting with objects a pretty easy task. In contrast, interacting with other people is much more complicated. As any parent of a toddler knows, putting a child on a bench carries no guarantee that they'll still be there when you get back. So, we need more complicated rules to predict and explain the actions of other people, and these rules often involve imagining what others are thinking and feeling. One such rule is that people's actions will be guided by what they think is true, rather than what is actually true.

Imagine a situation where a boy has put away his toy train for safekeeping while he's out playing in the yard. While he's outside, his sister comes along and gets the train out to play with it, leaving it somewhere different when she's done. Where will the boy look for the train when he next wants to play with it? Where he put it or where his sister did? Hopefully you agree with most 5-year-olds, who confidently predict that the boy will look for the train where he put it and not where it ended up. Most 3-year-olds, by contrast, predict the boy will just look for it wherever it actually is.

In last summer's newsletter we described a study showing that one reason 3-year-olds have such trouble reasoning about others' beliefs is that they don't have enough self-control to put aside their own knowledge about the world in order to reason about someone else's knowledge. Currently, we're aiming that same question – how much self-control do we need to take someone else's point of view? – at a younger age group. Though obviously 18-month-olds can't provide the right answer to a story like the one told above, research from other labs has shown that toddlers this age might have a better understanding of beliefs than we thought. These researchers set up a similar scenario where a person has a false belief because their possession got moved while they weren't watching and then used looking time – a good measure of infants' and toddlers' surprise – to see where the 18-month-olds expected the person to look for the object. It turns out that, just like 5-year-olds, they expected the person to look in the empty location where they had previously left the object!

Our current study uses methods like this one, as well as measures of self-control and short-term memory, to see if the 18-month-olds with better self-control are the ones that are best able to make these kinds of predictions about others. Data collection for this study is ongoing, and hopefully the results will help us figure out the ability to take others' perspective matures from this early stage which guides looking times in toddlers to 5-year-olds' full-fledged ability to explicitly discuss what someone else thinks is true!

Measure Words

Peggy Lee, Post-Doctoral Fellow; Ruthe Foushee, Research Assistant

One of the fun aspects of coming into the lab is getting to realize things that you maybe hadn't thought about having had to learn as a kid – in the case of this series of studies, about counting and the meaning of measure words. If you have a toddler at home, you may have noticed that while your child can count pretty well, there are times when he or she seems to have a different understanding of what makes up a unit than you do. For example, young children will frequently count a fork broken into three pieces as "three forks." However, they do not make this mistake with objects that have nameable parts. Because the pieces of a broken bike, for example, have individual names (e.g. brakes, chain, wheel, handlebar), at the same age that they are counting a broken fork as multiple forks, kids have no problem recognizing that pieces of a bike are not "bikes" themselves.

This study investigates the relationship between children's acquisition of measure words (as in, a piece of a fork, a slice of apple, a cup of sand) and their concepts of quantification. The aim was to change children's behavior by introducing the term "a piece" as a name for fractions of objects, making simple broken objects like forks, socks, and rubber bands more like bikes with nameable parts. The current investigation joins other training studies in trying to teach 3-5-year-old children the contrast between a piece and a whole: both that a whole fork would never be called "a piece of a fork," and that a third of a fork would never be called "a fork." As a result of the training activity, which involves counting, naming, and identifying a set of broken objects while receiving frequent feedback, we were able to decrease the number of children who accepted the label "a fork," for example, for a piece of a fork's handle.

As part of the same body of research on how young children talk and reason about quantities, a three-part study explores specifically how they use unitizers with substances. In the first part, a "quantity judgment" task, children are asked to judge which of two piles of sand is greater. We have found children to be remarkably good at this, and even able to distinguish when the ratio between the volumes is 4:5. In the second task, children are shown sand in containers and arranged in different shapes on a series of plates. A specific unit of sand (for example, a line of sand) is requested, and the child is asked to point to the plate that matches the given description. In the third task, a "measure words" task, we investigate how children understand units like cups to measure a substance like sand, and whether they use those units to help them quantify amounts of a substance. In this part, the child is asked to decide whether a quantifying phrase ("Is this three cups of sand?") matches a display (a pile of sand poured from three full cups). While it is clear that children at this age are comfortable with the individual tasks of counting cups and gauging quantities of sand, the difficulty of the "measure words" part is ultimately linguistic because children must combine the discrete unit ("three cups") and the substance ("sand") to understand the meaning of the phrase.

Studies like these, whose goal is to better understand how children come to apply measurement and counting language, and encourage their progress toward more adult-like use of quantificational terms, have positive implications for early math education.

It's Not Bad, It's Modern!

Emily Orlins, Thesis Student

Imagine it is your birthday, and a new friend gives you a gift—a homemade knitted pair of socks. You do not need another pair of socks, and you think these socks are atrocious. Despite your feelings toward the socks, you graciously thank your friend, as most adults would, and say that you like them. This type of lie is classified as a white lie—an untruthful statement told with good intentions. While many types of lies are antisocial, white lies are prosocial, meaning they have positive value in social interaction. In telling your friend that you like the socks, you are purposefully trying not to harm that person. Furthermore, you might be particularly inclined to lie about the gift if your friend was sad to begin with. Identifying someone else's emotional state and responding to it is an imperative part of social interactions.

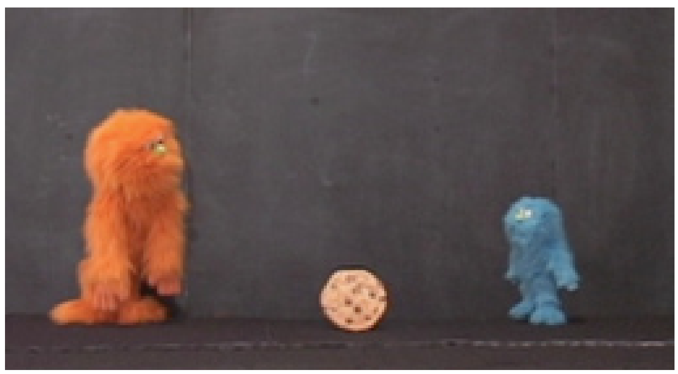
Previous research has shown that children as young as 3 years of age are capable of telling white lies for politeness and flattery. There has been little research done regarding children's motivations behind telling white lies, as well as their understanding of these motivations. In this study, we examined children's ability to use white lies for prosocial purposes. To what extent are children motivated to use a white lie to cheer someone up?

This study investigated children's capacity to tell a white lie to make someone feel better, as well as whether children could learn this ability. We tested 51 children between 7 and 11 years of age. The first two experimental trials tested whether children would tell a white lie spontaneously, while the second two experimental trials tested whether children would tell a white lie after an adult modeled how to do so. The results showed that children ages 7 to 11 understand that telling a white lie can be used to make someone feel better. They were able to differentiate between the sad and neutral person, and they lied more often to the sad person. After the modeling session, subjects lied more often in both the Sad and Neutral conditions. This study shows that starting at 7 years of age, children tell white lies for prosocial purposes. These findings provide insight into the relationship between prosocial behavior in children and their understanding of emotion.

Big and Mighty

Lotte Thomsen, Post-Doctoral Fellow;
McCaila Ingold-Smith, Lab Coordinator; Ruiting Song, Research Assistant

In the last Newsletter, we described a study that tested if infants understand when the goals of two agents conflict and if they expect the bigger agent to "win" over the smaller one in this case. Specifically, we showed infants a large and a small agent walking towards one another across a stage and meeting in the middle, blocking each other's way. After this, one of the agents bowed to the other and scooted to the back of the stage, yielding the way to the first agent. We have found that 8-month-old infants have no expectations as to whether the larger or the smaller agent will yield to the other one when one blocks the other's path of motion, but by 9 months infants begin to expect that the smaller agent will get out of the way of the bigger one. By 10 months, infants are robustly surprised if a small agent "wins" over a larger one. We are excited to report that this study was published in Science in January!!



We are now continuing to pick apart what infants really understand about this situation. In particular, we're curious to see if the act of bowing alone is enough for infants to distinguish between the two events portrayed in the original study. Although bowing is a widespread sign of submission among animals (and many human cultures), it is questionable whether infants, who lack experience seeing people bow, would understand such an action as submission.

To test this we had 12-14 month olds come in to watch the animations from the first study—this time, however, the animation froze right after one of the agents bowed. Results showed that infants were not surprised when they only saw the bigger agent bow to the smaller one. This means that infants might rely on the whole context of the original study to understand the process of conflict resolution and goal-completion. We think this is pretty interesting and look forward to sharing more results as we further explore this line of research!!

How Children think about Right and Wrong, Rules and Punishment

Alex McNaughton, Thesis Student

Adults recognize a distinction between acts that are wrong and acts that will be punished. Typically, you will be punished only if you are found to have done something that is forbidden by rules and backed by sanctions. In this study we ask at what age do children understand this distinction?

In a classic study, Judith Smetana showed that almost all 3, 4 and 5 year olds think that if there were no rule saying that you shouldn't, it would be okay to leave your blocks out on the table. However, around half the children said that even if there was no rule saying you shouldn't, it would still be wrong to hit someone. This finding was interpreted to show that even by 3 years old, children are very sophisticated. They think that some things (like leaving your blocks on the table) are wrong because there is a rule against them, but that other things (like hitting someone) are wrong even if there is no rule against them.

In this research, we challenge this interpretation. This interpretation assumes that children know that "being prohibited by a rule" and "being wrong" are two different things. In other words, it assumes that they know, for example, that hitting could be wrong but not prohibited by a rule. In the study, we asked children to predict whether a child would be punished. In one story, the child hit another at school with no rule against hitting. In a second story, the child left his blocks on the table at a school with no rule against that. Hardly any 3 and 4 year olds that we asked predicted that the child who left his blocks on the table would be punished, but about half the 3 and 4 year olds said the child who hit would be punished. This finding suggests that 3 and 4 year olds may not really grasp the possibility that there could be no rule against hitting. They think it is just part of the structure of the world that hitting is prohibited by rules and is punished. Thus when half the children in Smetana's original experiment say that hitting is wrong even if its not prohibited by a rule; they may not be thinking "hitting is wrong even though its not prohibited by a rule." Rather, they may simply be deeply confused. They know that hitting is wrong and they expect that wrong things will be prohibited by rules and be punished. Thus they cannot conceive of the possibility that hitting would not be prohibited by a rule. Unable to grasp this possibility, they guess wildly: 50% say hitting is wrong if there is no rule and 50% say it is okay.

Infant Expectations about Conformity

Lindsey Powell, Graduate Student

In last summer's newsletter, we described a new study on what infants think about social groups and their behavior. As adults we often use individuals' social group membership to predict their behavior. For example, imagine meeting a two people from a country you've never been to and finding out that they eat a food you've never have. Chances are that if you met a third person from that country you would expect them to eat the same food their compatriots ate. Our study asked whether infants make the same kinds of generalizations by introducing them to two groups of animated characters. One group consisted of three red circles and the other of three yellow triangles. There were also two stationary boxes on the screen, and infants saw that two of the red circles jumped on one of the boxes and two of the yellow triangles jumped on the other box. We found that 8-month-olds (but not 4-month-olds) expected the third circle and the third triangle to copy their group members; when the third character didn't conform to the group action the infants stared at the screen significantly longer than when he did. We found a similar result with 12-month-olds when we replaced landing on boxes with jumping and sliding actions.

Although this result was very exciting, we also thought it might be possible that the infants' reasoning had nothing to do with the social world. Maybe they just learned to expect a particular kind of shape to land on a particular box. So, we carried out a follow-up study where we took the eyes off the characters and made them look and move more like inanimate objects than animate beings. The infants still saw two of the red circles land on one box and two of the yellow triangles land on the other, but this time they no longer cared whether the third circle landed on the same box as the other two circles. They looked equally long at either type of event. This result, combined with our initial findings, suggests that infants reason about social categories in a special way and use them to make generalizations that they won't make in the case of inanimate objects.

Still, there was a lot of information present in our initial study, and we are wondering what parts were most important for prompting infants to make the behavioral generalizations that we saw. In addition to the fact that the characters in each group all looked the same, they also performed several dance sequences at the beginning of video in their separate groups. We're wondering whether it's the similarity of appearance, the social aspect of the dancing, or both that lead the 8-month-olds to expect that the third circle character would do the same thing as the other two. To test these questions we're running two ongoing studies, one where the characters still look the same but never dance together and another where the characters still dance in two groups of three but all the characters look different from one another.

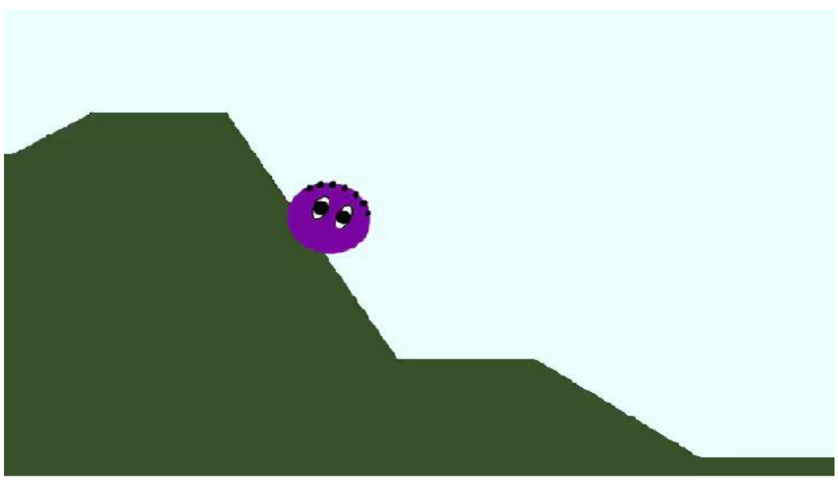
In two studies with 4- and 12-month-olds, we're also asking whether infants can do this kind of reasoning in reverse. If they see individuals acting similarly to one another, will they then expect those individuals to be friends and members of the same social groups? We're looking forward to sharing the answer to this question in the next newsletter!

Expectations about Emotions

Amy Skerry, Graduate Student

Human infants are sensitive to the emotional expressions of others. They can discriminate facial expressions associated with different emotions and match congruent facial and vocal signals (i.e. a sad face to crying sounds, a happy face to happy vocalizations). Infants are also able to use the emotional expressions of others to learn about the world. A nine month old infant, for example, will use its caretaker's emotional reactions towards an object to guide its own behavior with respect to that object.

However, in these studies, infants rely on cues that are directly observable in a facial expression or vocalization. We were interested in finding out whether infants this age are also able to infer the internal emotional state of an individual in the absence of any observable affect. In the Expectations about Emotions study, we begin by asking whether infants have an understanding of the sorts of situations or events that elicit different emotional expressions. As adults, we understand emotions not only as communicative signals that tell us about objects or events in the world, but as expressions of internal states that a person might experience in response to various outcomes. Do infants understand that there are certain situations that make others feel happy, and situations that make others feel sad?



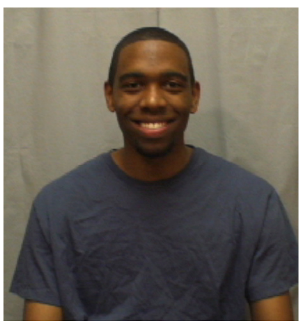
In this study, we present 10 month old infants with an animated shape that attempts to climb a hill. The shape either succeeds and makes it up to the top of the hill, or fails to reach its goal and tumbles back down to the bottom of the hill. The shape then gives an emotional response that is congruent or incongruent with the outcome. We compare infants' looking time to these four events (success+happiness, success+sadness, failure+happiness, failure+sadness). If infants expect the shape to be happy upon completing its goal and sad when it falls back to the bottom, this might be reflected in increased looking time to emotional reactions that are incongruent with the observed outcome.

So far, infants do not seem to distinguish between the congruent and incongruent emotional reactions. One possibility is that infants this age really don't understand that certain events elicit particular emotional responses. However, it is also possible that infants have the ability to infer emotions from situations or outcomes, but do not have expectations about the particular outcomes used in this study. Perhaps there are other events (i.e. physical harms, aggressive and affiliative social interactions) that are more salient to infants, and that infants would link to appropriate emotions. Future studies will follow up on these possibilities.

Face Preference Studies

Talee Ziv, Graduate Student

In this ongoing line of work we are interested in investigating babies' responses to faces of different races. As reported in previous newsletters, our earlier studies found that three-month-old infants typically look longer at own-race faces when paired with faces of an unfamiliar race. However, this preference is only observed when male pairs are presented. When two females are shown race does not seem to influence babies' pattern of looking, as they will spend an equal amount of time attending to both faces. Why are male and female faces treated differently? Research with adults suggests that out-group male faces are perceived as more threatening than own-race faces, so we were curious whether this explanation could apply to our findings with infants as well. In order to test this idea, we conducted two experiments that sought to reduce the threat level of the male faces. Our rationale was that if indeed the observed own-race preference has something to do with threat then our experiments should show an attenuation of this preference.




In the first study, participants were presented with eight pairs of own- and other-race faces matched for gender, all displaying an averted gaze (faces were looking away from each other). Adults find averted gaze less threatening than direct gaze, and we know that infants also notice eye gaze direction. We measured looking time at each of the faces within a pair and found that despite the change in gaze direction, infants still looked longer at the own-race male faces, and looked at female pairs equally.

Gaze direction is a very subtle cue, so we thought that perhaps a stronger approach is needed in order to bring about a change in babies' reactions to the photographs. Therefore, in the next study we provided infants with ample information that the individuals they are about to encounter are nice and friendly. Specifically, participants were shown a short video clip in which two males (one African-American, the other Caucasian) smiled and spoke in a positive infant-directed manner. Infants were then presented with 8 pairs of still images of the same two males who appeared in the video. We predicted that if the interaction at the beginning of the experiment was sufficient for infants to perceive both men as equally sociable, then they should show no bias in their looking time pattern. However, our results yet again showed a visual preference for the Caucasian male.

We are currently engaged in a new project examining infants' social reactions toward these same clips as another way of measuring preference beyond looking time. We are interested in whether 3-month-old babies will smile, coo, or look away more depending on the person they are observing on screen. This study is in its very early stages, but we look forward to telling you about our findings in the next newsletter!

Children's Use of Length vs Distance for Navigation

Sang Ah Lee, Post-Doctoral Fellow

What geometric properties do children reorient by? Past studies have shown that children show successful reorientation in rooms of various shapes; however, these past studies do not reveal which geometric properties children relied on, as they were never teased apart in the arrays tested. This study addressed this problem by testing the geometric properties of distance between wall surfaces and lengths of wall surfaces in isolation (see photos).

Distance Test

Length Test

The game children played involved hiding a sticker under one of the round disks placed at the corners of the arrays, spinning around with their eyes closed, and then searching for the sticker. When Distance alone was tested using 4 walls all at the same length, placed for form a fragmented rectangle (2:1 ratio of distances), children searched for the stickers according to geometry (by limiting their searches to the correct location and the diagonally opposite location). However, when length alone was tested using 4 walls at two different lengths (2:1 ratio) placed to form a fragmented square (no distance differences), children searched for the stickers randomly among the four hiding locations. These results show that early cognitive mechanisms underlying navigation and reorientation are specifically attuned to distance relationships in the environmental terrain.

Using Intonation and Rhythm

Jean Crawford & Kate McCurdy, Lab Techs

This is part of a larger study that looks at how children and adults make use of different kinds of information to understand sentences. To understand what someone says, a listener must identify individual words and then group them together into meaningful units to determine the meaning of the whole utterance. Since the typical speaker produces about 3 words per second, we have to do this very quickly. Combining the words in different ways gives us different interpretations of the meanings of the sentences we hear.

Take one example – "She hit the thief with the lamp." This is an ambiguous sentence: you can interpret it in different ways if you combine the words together in different ways.Two possible interpretations are:

· Modifier interpretation: as a listener, you can combine the prepositional phrase "with a lamp" with the noun phrase "a thief," making a group so that the phrase "with the lamp modifies the noun "thief." You would then interpret the sentence as saying "She hit the thief that has the lamp."

· Instrument interpretation: you could also combine the prepositional phrase "with the lamp" with the verb "hit," so that the lamp is interpreted as an instrument used in the action "hit." You would then interpret the sentence as saying "She used the lamp to hit the thief."

When a listener hears such a sentence, s/he needs to figure out which of the two interpretations the speaker intends. We are interested in seeing what kinds of information children, in particular, use to guide their interpretation of such sentences. We are conducting the same study with adults and children so that we can find out how language development and strategies of disambiguation change as we develop.
Some of the sentences you heard were ambiguous in the same way as our example above – they could mean more than one thing. We manipulated the prosody, or intonation and rhythm, of the sentences to find out whether it has an effect on how children and adults interpret sentences. For example, we think adults are more like to chose a modifier interpretation of a sentence said like this: "You can feel… the cat with the feather," than if they heard it said this way: "You can feel the cat… with the feather." Interestingly, we're not sure whether children will react in the same way as adults or not.

Later we will look at the videotapes to see both how you interpreted the instructions (what you did with the toys), and what you were looking at as you heard them. In particular, we want to see how you interpreted phrases like "with the feather" – did you interpret the feather as a description of the toy cat or as an instrument to be used for feeling the toy cat? – and whether your interpretation depended on the prosody of the instructions you heard.. Our hypothesis is that, for both children and adults, a prosodic pause between words like "cat" and "feather" will result in an instrument interpretation and vice versa as described above.

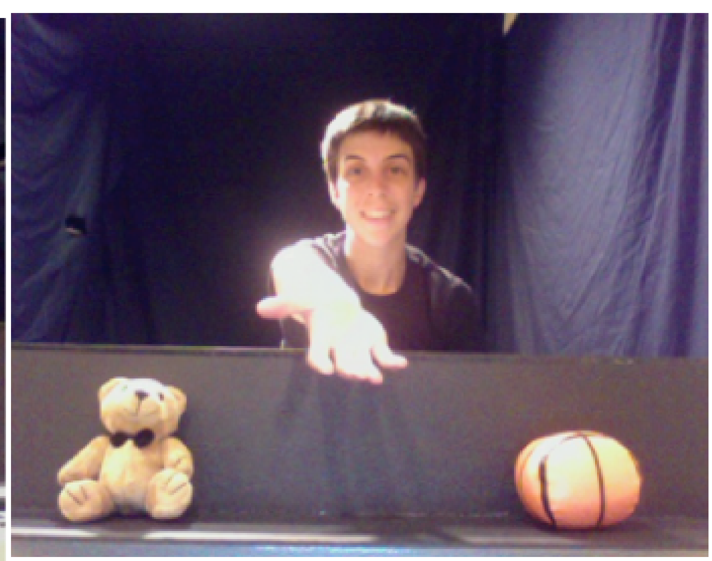
Infants' Understanding of Helping

Kathryn Hobbs, Graduate Student

Infants know a surprising amount about people and in particular their intentional or goal-directed actions. For example, from about 5 months and perhaps even younger, infants reason about people's actions in terms of goals like objects as opposed to just random movements through space. And it seems they may even understand that people can have a preference for one object over another. Given this robust understanding of people's goals and preferences, perhaps infants can read others' actions and use this information to help them appropriately. That is, having seen an adult like one toy better than another, will an infant give the actor the one she likes best when she needs help?

In this set of studies with 14-month-olds, we are running three experiments designed to ask whether infants can use an adult's actions to figure out her preference and help her accordingly. In experiment 1, infants see the actor reach for her preferred toy three times. Then in the test trials the objects are out of her reach and she asks the infant for help, not giving any indication at this point which object she wants. Infants in this study have so far helped randomly, not tending to give the preferred object more often than the other object. To follow up on this, we are running a similar study that gives infants more opportunities to infer the actor's preference before helping her. So far, though, this has not improved infants' performance—they still help her without regard to her preference. We're also running a control study to see if infants give the actor the preferred object when it is readily apparent which object she wants. In this version the actor is reaching directly to one of the objects in the test trials, and infants so far have responded by giving her this object most of the time.

The results from this bundle of experiments indicate that at 14-months infants are still developing an understanding of how to be appropriately helpful. We don't know yet whether infants this age lack awareness of others' desires or whether their understanding of helping does not include specific preferences. We look forward to investigating this further and sharing the findings with you soon.



Numerical Cognition

Saeeda Khanum, Visiting Graduate Student

There are two number systems that play a great role in human development throughout life: one is the approximate number system, and the other is the exact number system. Humans and animals both use the approximate number system. This system is imprecise: we use this system, for example, by figuring out the difference between two stimuli through approximating the ratio.. This approximate number system is functional from very early in life and is independent of language and education. There is a second exact number system for precise representation of objects and it is limited to up to 3 objects in children and 4 objects in adults. Humans go beyond this limit of 4 objects with the help of language, and from childhood they start learning the exact number system.

Many previous studies indicate a bidirectional relationship between these two number systems. However, causal relationship between these two systems is yet to be determined.

To find out the causal relationship between these two systems, we conducted a research study on first grade children. Specifically, we investigated whether training children with approximate, non-symbolic arithmetic problems will offer an advantage when these children were then asked to solve exact (non-approximate) arithmetic problems. Participants were all in first grade, and were between the ages of 6 years and 5 months to 7 years 5 months. They were split into two groups, and gender and mean age were equal. One group (experimental) was trained in non-symbolic arithmetic problems and the other group (Control) was trained in dark vs. bright color comparisons. Both games were on a computer.

Children in the experimental group saw a set of dots first on the left side of the screen and then another set of dots on the right side of the screen. After that, both sets of dots moved to the center of the screen and were combined. Then, children saw a third set of dots and had to decide whether this third set is more or less than the previous two combined sets.

Children in the control group saw a colored blob that shrank into a circle, and then changed to a lighter or darker shade. Children were asked to decide whether the circle's color is lighter or darker than the blob's color.

After these games, children in both groups solved 4 sets of arithmetic problems. Children also played another game in which they saw two sets of colored dots on a computer screen and they had to guess which side has more dots.

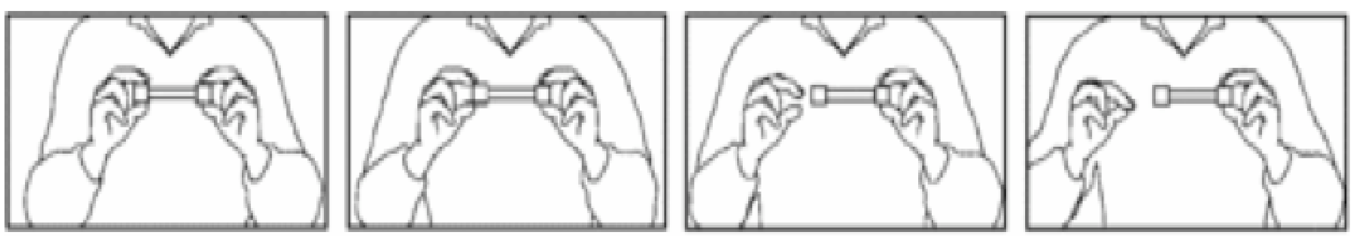
Preliminary results show that children who solved the non-symbolic arithmetic problems (experimental condition) were faster in solving math problems than children who completed the color-comparison tasks (control condition). However, there is no significant difference between both groups on accuracy. We hope that the findings of this study will further direct the most effective way to teach math to children!

Early Theory of Mind in Deaf and Hearing Children

Kathrynn Hobbs, Graduate Student; West Resendes, Thesis Student

As adults we constantly explain other people's behaviors in terms of mental states like goals, desires and beliefs. For instance, we reason that Sarah must have poured salt in her coffee because she thought it was sugar and she wanted her coffee sweet. This comes naturally to us, but is no small feat. Children can't explain others' actions in this mentalistic way until around age 4, though emerging findings have shown that even one-year-olds to have an implicit understanding of others' beliefs. Researchers refer to this understanding as reflecting a "Theory of Mind," and it has been an active area of research within developmental psychology for the past three decades.

Interestingly, it seems that language acquisition may play a substantial role in the development of Theory of Mind. One piece of evidence for this is the finding that deaf children who are delaying in learning language lag behind their same-age hearing peers when it comes to understanding others' mental states. Given this in conjunction with recent findings on infants' Theory of Mind, we wonder whether deaf infants will similarly be delayed in social understanding at an even younger age.



This study measures 18- to 24-month-olds' Theory of Mind understanding from several angles and will compare deaf and hearing infants' performance on our battery of tasks. We use three tasks that measure understanding of others' mental states and a working memory task as well. The imitation task measures whether infants can infer an actor's goal when her actions are not quite successful and then imitate what the actor was trying to do, not what s/he actually did. The pointing task investigates infants' understanding and production of point for the purposes of both requesting and informing. The helping task asks whether infants use an adult's knowledge state in determining his/her desire and helping accordingly. Lastly, the working memory task requires infants to remember which containers they've looked in already to find a new toy.

We've started hearing children, who seem to perform as predicted by previous findings with these tasks. We will soon begin testing deaf infants, and predict that they may be delayed on some of the measures, but probably not all of them. As this is a brand new area of research, we're not quite sure what to expect and are very excited to find out!

Belief-Based Preferences

Larisa Heiphetz, Graduate Student

Previous research suggests that children use group membership to form social preferences. For example, children typically prefer to play with peers who are their same gender, and they prefer individuals who speak with the same accent as the child. However, past work examining children's reasoning about other people has focused on group differences that are immediately obvious—it's usually easy to tell what gender someone is or whether they share one's own accent soon after meeting them.

In this study, we were interested in whether children also form preferences based on other's beliefs. One possibility is that children are sensitive to differences in a variety of domains and would prefer those who shared their beliefs. Another possibility is that children only form preferences based on differences that they can see or hear, and that invisible differences don't influence children.

To test between these possibilities, we asked children about their own beliefs and then told them about pairs of characters. In each pair, one character shared the child's belief while the other character believed something different. We tested a few different kinds of beliefs—including religious, factual, and opinion-based beliefs—to see whether the type of belief mattered to children.

We found that children tended to prefer the character who shared their beliefs in all of the domains we tested. For example, children typically said that they would rather be friends with the character who shared their beliefs rather than the one who didn't. However, children did not use information about beliefs to guide their decisions about which character performed good or bad behaviors. For example, they ascribed equal numbers of positive and negative behaviors to the similar character.

We are currently conducting follow-up studies to help us learn more about children's preferences.

Beliefs and Practices

Larisa Heiphetz, Graduate Student

One of the studies conducted in our lab this year showed that children prefer those who share their beliefs but do not use information about belief similarities when deciding which character did a good or a bad behavior, like helping their friends or being naughty in school. In this study, we were interested in whether beliefs matter more or less to children than the behaviors that another person does.

We asked children about their own beliefs and activities, and then we showed them pairs of different characters. In each pair, one character shared the child's belief but did a different behavior, and the other character shared the child's behavior but believed something different. For example, if a child told us that she thought green was the prettiest color and liked to watch Sponge Bob, we would say that one character thinks green is the prettiest color but does not watch Sponge Bob, while the other character watches Sponge Bob but does not think that green is the prettiest color. Then we asked questions about the child's preferences (e.g., "Which of these children do you think you would rather be friends with?") and which character the child thought did a good or bad behavior.

We are interested in whether children tend to pick the character who shares their beliefs or their behaviors when answering these questions. Data collection for this study is ongoing, and we look forward to sharing the results with you when the study is completed!

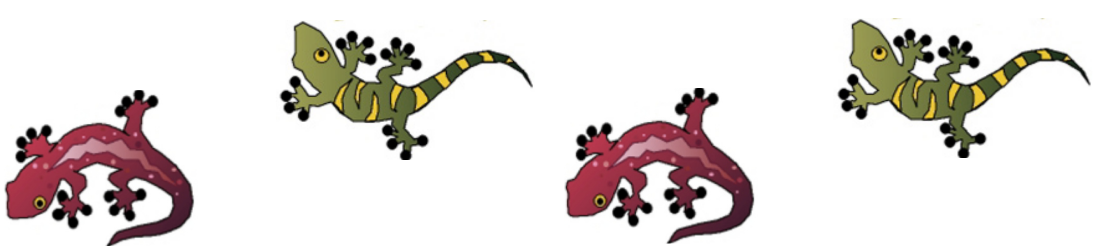
Malleability

Larisa Heiphetz, Graduate Student

In this study, we were interested in whether children think that beliefs change or stay the same after specific types of changes. We told children about characters who held a particular belief, and then told children that the character moved to a different place (changes in space), or that the character grew up (changes in time), or that the character found out that lots of people disagreed with him/her. We then asked children whether they thought the character would continue thinking the same thing or whether they would think something different.

We were also interested in whether children reason differently about different types of beliefs, so we used several types of beliefs in this study. On some trials, the character had a particular preference, such as thinking that a particular song is the best one. On other trials, we described a factual belief, such as when a particular song was written. On still other trials, we told children about a religious belief, such as thinking that a goddess hears people's thoughts when they think about a particular song.

Our preliminary results suggest that children responded differently to different types of changes. They were most likely to say that the original belief would stay the same after the character moved to a new place and least likely to say that the original belief would stay the same after the character grew up. The third type of change, learning that others disagreed with the character, produced intermediate responses. However, children responded similarly to all the beliefs that we used, suggesting that the type of change (like whether someone moves or grows up) may matter more to children than the type of belief (like whether it is a belief based on preferences or facts).



Number and the Infant Brain

Dan Hyde, Graduate Student

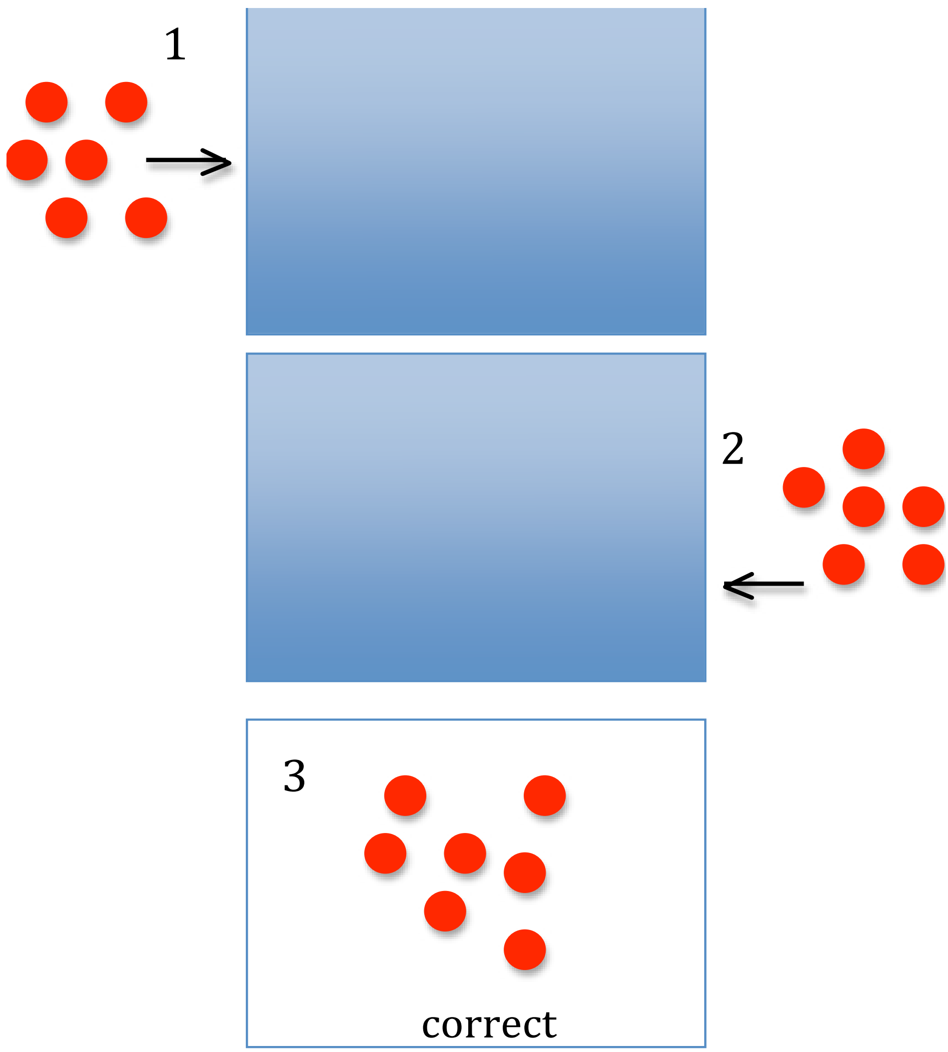
The Lab for Developmental Studies has a long history of studying the numerical competencies of preverbal infants. Over the years, we have come to learn that the brain constantly encodes and compares visual stimuli based on number even in infancy. However, most of these discoveries were made using measures of behavior. More recently we have begun to explore early numerical competencies using measures of the brain.

Localizing numbers in the brain

One line of work seeks to discover which brain areas are responding to number. Using near-infrared spectroscopy (NIRS), we measured changes in the regulation of blood flow over different parts of the brain. Brain regions that respond to numerical changes are thought to be sensitive to number. Brain regions that respond to numerical changes, but not other types of perceptual changes (for example: size, spacing, color, shape) are thought to be dedicated to numerical processing. Recently we published a study taking measurements over four hypothesized regions of the brain and found that only one of them, the right inferior parietal region, responded to numerical changes (Hyde, Boas, Blair, & Carey, 2010). The study we are currently conducting follows up on this work by taking measurements from 10 brain regions simultaneously. The progress made on this study was mostly methodological, solving such problems as constructing headgear to hold the NIRS fibers securely on the head of each infant, acquiring accurate measurements from all 10 regions, and presenting stimuli in the most engaging way possible. Now that we have worked out some of these methodological details, we can begin collecting experimental data on number processing in these 10 regions.

How does the infant brain add?

You might have thought your child would have to wait till elementary school to learn how to add. This is not exactly the case. Research has shown that young infants have the capacity to form expectations about the numerical sum of two collections of objects (e.g. McCrink & Wynn, 2004). In these studies, infants watch one collection of objects appear on the screen and then move behind a box, see a 2nd collection of objects appear and move behind the same box, and then the lid on the box drops to reveal a 3rd collection of objects. Infants are surprised if the number of objects in the box (3rd collection) is far from the actual number of objects that should be in the box if the first two collections were added together, but are not surprised if the number of objects in the box is close to the actual sum of the first two collections. We are currently using this same paradigm to test what happens in the brain when infants see the box open. That is, presuming the brain is adding the two arrays, how does the brain respond when the 3rd collection is close to the actual sum compared to when it is far from the actual sum? To do this, infants wear a 128 sensor EEG net that passively measures the ongoing electrical activity from the scalp. When large groups of cells respond in conjunction, they produce electrical activity that can be observed on the scalp with the EEG net. After taking these recordings we can compare the electrical activity to look for similarities and differences in brain processing both between experimental conditions and to other studies of numerical processing in infants and adults (e.g. Hyde & Spelke, 2009; Hyde & Spelke, 2011). We are currently in the data collection phase of this study. Stay tuned to find out what we discover.



Teaching Ten

Yeshim Iqbal, Lab Coordinator; Brooke McDowell, Research Assistant

Previous studies have shown that children learn how to count before they understand what the individual number words mean. They know to say the word ‘ten’ after the word ‘nine’, but don’t necessarily understand what the words mean on their own. For example, if there are 10 objects on a card, without counting, an adult can estimate that there are 10 items there, while a young child may not know what it means to be 10 quite yet. In this study, we are trying to better understand the process that young children use to construct the meanings of number words. To do so, we have designed a task in which we attempt to “teach” children the word “ten” by contrasting 10 objects with another number of objects (e.g. 10 fish vs. 5 fish, or 10 cows vs. 20 cows). We are interested in knowing whether the children will be able to understand the number ten in this context, where we try to use approximations, instead of precise values, to teach the number word.

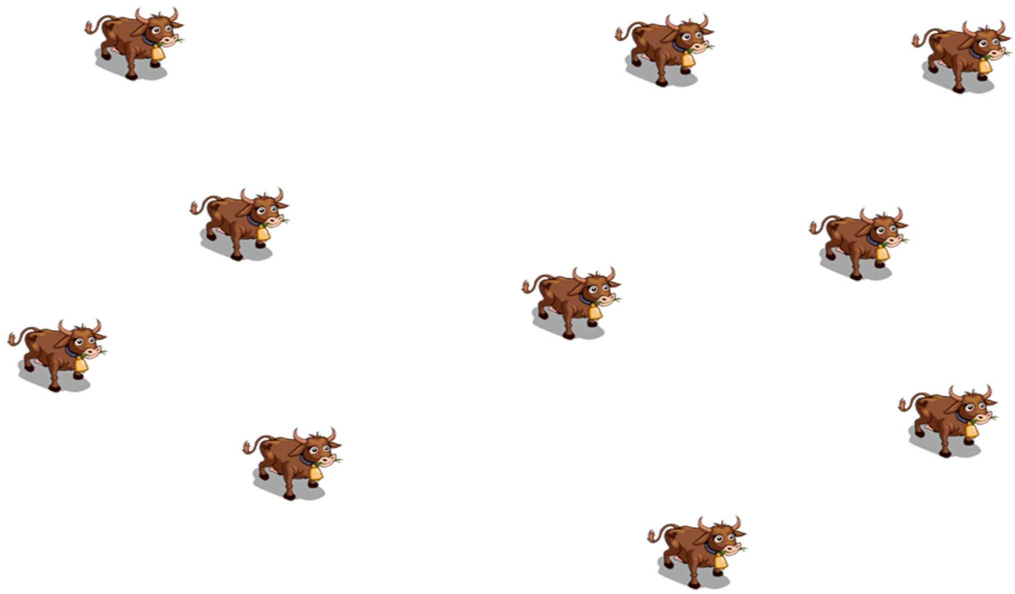
In the study, the children first go through training and up to three practice phases. In the training phase, the experimenter presents the child with two cards. One is the target card (e.g., 10) and the other card is a distracter card (e.g., 20). During the training, the experimenter explicitly points out the difference between the two cards. For example, the experimenter will say: “this card (while pointing to the target card) has 10 birds. This card (while pointing to the distracter card) over here has twenty birds, but not ten!” We contrasted 10 with the numbers 3, 5, 7, 15, 20, and 30. In the practice phases, the children pick which card they think has 10 animals themselves, and are provided with feedback (“Great job! That one does have ten!” or “Good try, but the other one has ten.”) Since we’re looking at their use of approximations, we encourage them to guess, not to count. In the final test phase, they see new cards (with the same ratios of numbers) that they have not seen before and are asked which ones have 10, with no feedback.

We are finding that three year olds are not succeeding at this task. While they almost always succeed on the 10 vs. 3 ratio, they do no better than chance on any of the other ratios, in both the practice and the test rounds. Four year olds do somewhat better, but are not consistently succeeding. This result sheds light on the underlying processes that might be involved in learning number words, suggesting that appealing to the number system which deals with approximations may not work in teaching number words.

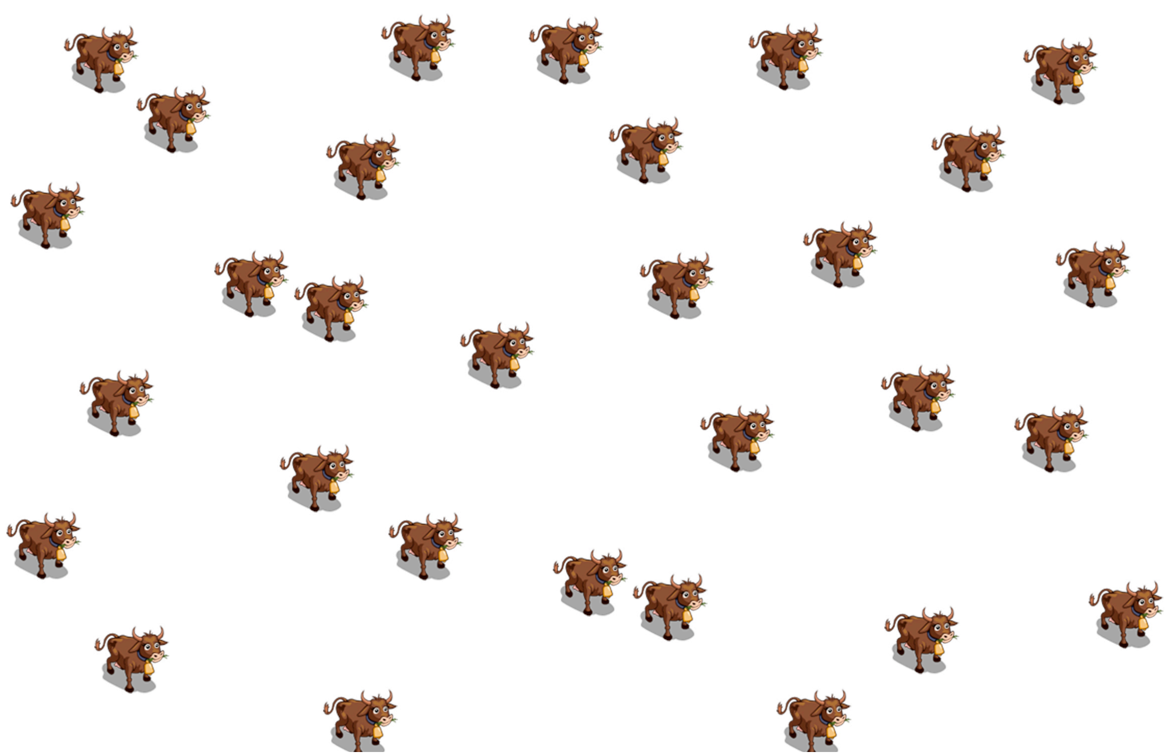
Additionally, with the four year olds we added a task where we briefly showed them pictures of differing numbers of dots, and asked them to tell us how many they thought they saw. Children who say higher numbers when they see more dots are called “mappers” (that is, they understand that more objects are associated with number words later on in the count list.) We wondered whether children’s ‘mapping’ ability would be related to their performance on the teaching ten task, thinking that perhaps children who were mappers would do better. But we found no connection between their mapping ability and their performance on teaching ten. This raises interesting questions about what exactly the difference is in the number knowledge between the children who succeed and those who don’t – we’ll keep you updated in the next newsletter!







Which one has ten?



Studies on Symbolic Understanding in Children

Nathan Winkler-Rhodes, Graduate Student

When we read picture books with our children, look at photographs, make drawings, and play with representational toys (like a plastic piece of fruit), we expect them to understand that each of these entities is meant to refer to something other than itself. That is, we expect them to know that picture-books refer to hypothetical or imaginary states of affairs; that a family photograph refers to events that happened in the past; that a drawing is meant to refer to a generic kind (e.g., if you are just drawing some non-specific animal) or to a specific individual (e.g., if you are drawing your family); and that toys are meant as surrogates for real things. Do children understand all this? When do they master these distinctions, and what drives developmental change? Each of the following three experiments addresses different facets of this fundamental question about children's symbolic functioning.

1. Infant Symbolic Understanding Study

When do children begin to appreciate that pictures can refer to things? We addressed this question with a hide-and-seek game: 18-month-old infants watched as an experimenter hid a small, novel toy in a box, in such a way that the infant was not able to see what toy was hidden. Before they were allowed to search the box, the experimenter showed them a picture of the hidden object, either labeling it ("look, it's a blicket! I put a blicket in the box!") or merely referring to it without labels ("look at that one! I put one of those in the box!"). Finally, children were allowed to search the box, at which point they found either the depicted object or, by experimental deceit, another object. Our critical measure was how long infants searched the box, after removing this first object. Our prediction was that if children understood the picture to be denoting the kind of thing that was hidden in the box, they would search longer after finding a mismatching object than after finding the one shown in the picture, as if acting on the belief that the pictured object ought to still be somewhere in the box. We further predicted that this result would be more pronounced when the entity in the picture was not given a label.

In fact, we found that overall, children failed to search the box any longer on matched versus mismatched trials, no matter whether they were in the label or the no-label condition. Because our results suggested a possible weak effect of condition, however, we are now running this experiment with older babies to see at what age the effect might become more pronounced, if ever. Finally, to be sure that our failure was not due to some extraneous property of the task, such as children not wanting to reach into the box at all or finding it so fun that they reach no matter what their beliefs about its contents, we ran a version of the task that had no symbols in it—children simply watched an object get hidden and were then encouraged to reach in and find it. The trick was that sometimes the experimenter swapped out the hidden object for another one, using a trap door on the back of the box. This experiment worked—children searched the box longer after removing a surprise object. This suggests that our fundamental measure is sound, and that the null effect above may be due to children not yet understanding the referential function of pictures.

2. Map-reading in 2-year-olds I: using photographs to locate a hidden doll.

A follow-up project to the above studies 24-month-old children's ability to use pictures to determine where a doll had been hidden in a room. Our hypothesis was that early in development, children find it more natural to interpret a picture as indicating a generic kind of thing as opposed to a specific individual. To test this idea, we had children try to find a hidden doll by observing where an experimenter pointed to a photograph of the hiding room, which was outfitted with 3 possible hiding locations (behind a chair, in a bucket, or under a table). In the Generic condition, children were told that Mr. Froggy was hiding "behind one of these," while in the Specific condition, they were told that he was hiding "behind this one," while in both cases the experimenter was pointing one the correct location on the picture. Our finding supported our prediction: when the location was described as "one of these," children were quite adept at locating the hidden doll. When, however, the location was described as "this one," children had difficulty locating the doll, and in fact performed no better than what would have been expected by chance. More follow-up work is necessary to determine the cause of the effect, but it is so far consistent with our hypothesis that young children saw our picture as indicating some generic room, rather than the exact room that the doll was hidden in.

3. Map-reading in 2-year-olds II: using abstract maps as cues for placing a doll.

This year saw the completion of a long-running study on how 2-year-old children think about maps. Our questions were, first, whether young children could see a picture as denoting where something is located, as not merely what something looks like; and second, what cues help children to discover the representational nature of a map. We had previously found that by age 30 months, many children can indeed read abstract maps—they can use a drawing of 3 identical objects (distinguishable only by their spatial positions) to figure out where to place a doll. We had further already learned that children were very sensitive to two properties of the task—the use of labels to describe each entity in the map (Study 1), and the extent to which the maps resembled their real-world referents (Study 2). In Study 1, when we didn't label our maps and they were abstract, children performed quite poorly—they in fact tended to try to place the doll on the map itself, as if not seeing it as a representation of the room. However, they succeeded when labels were provided, and, in Study 2, also when the maps resembled their referents (i.e. by being faithful line drawings of a set of chairs).

The goal of our most recent work (Study 3) was to resolve an ambiguity in these previous studies. We were particularly curious whether the apparent effect of resemblance was itself a sort of effect of labels. Consider that, if children are familiar with entities like chairs and buckets and know names for them, when they see a faithful representation of such objects they could name it themselves, regardless whether the experimenter did so too. Were children in the No-label condition of Study 2 essentially putting themselves in the Label condition? To answer this question, another study used faithful drawings of novel objects—things we made up, to ensure that children could have no familiar label for them—in the same doll-placing task as before. We only needed to run children through the No-label condition, as this was the critical test—if they require labels to facilitate understanding the pictures as representations, they should fail when they don't know what to call our images. But if all they need to see is that the map resembles its referents to know that it's a representation, they should succeed. We indeed found evidence for the second proposition: children performed just as well with novel objects as with familiar objects, suggesting that they use the properties of resemblance, and of labels, to judge what counts as a representation.

Paternalistic Altruism

Christina Wong & Jana Douglas, Research Assistants

Paternalism refers to the practice of making decisions for another person, using the justification that it is for the other person's good. For example, governments may act paternalistically by passing legislation that mandates helmets for bikers or seatbelts for car passengers. Parents often make paternalistic decisions for their children: telling them what they can eat, when they have to go to sleep, what television shows they can watch, etc. In this study we are interested in whether children show similar paternalistic tendencies.

In this study, children watch a series of four videos. Each of the four stories revolves around characters facing a paternalistic conflict. For example, in one video, a hungry character asks for something to eat and a giver character, who has to decide what item of food to give her friend. She must choose between a healthy food item, which the hungry character has said they don't want, or an unhealthy food item, which her friend has asked for. The giver doesn't know what to do, and asks the child for advice as to what item to give her friend. We are interested in knowing whether most children will advise the giver character to give her friend the desired item (which she wants although it's not healthy) or the undesired item (which is healthy but not wanted). We have not finished collecting data, but many children do seem to be making paternalistic decisions at an early age. This study is conducted in the Discovery Center at the Museum of Science with children aged 4-9 years old. With this study, we will gain deeper insight into children's ability to think about the relationship between helping and other people's needs.

Music Enrichment and Geometry

Samuel Mehr, Rachel Katz, Researchers;
Adena Schachner, Graduate Student; Kenneth Parreno, Research Assistant;
Yeshim Iqbal, Rosemary Ziemnik, Lab Coordinators

This study explores the effects of art instruction on young children's cognitive development. More specifically, we are interested in exploring the effects of enrichment activities involving music and visual arts on spatial and geometrical reasoning in 4-year-old children.

Previous studies in our lab have shown a connection between instrumental music lessons and enhanced geometrical reasoning abilities in navigation tasks, and between visual arts instruction and enhanced geometrical reasoning abilities in visual tasks. These studies, however, investigate groups of people who already study music, as opposed to randomly assigning children to receive different types of training. They therefore don't tell us about the direction of this effect. Our study is one of the first to look at cognitive effects of music and visual arts enrichment through a "true experiment." This study's design is similar to longitudinal studies from the field of medicine: it has random assignment with a pre-test, a longitudinal "treatment period" (the music or visual art classes), and a post-test.

Pre-test

During the pre-test, children took tests of verbal abilities and parents took music aptitude tests and provided detailed demographic information. Children were then randomly assigned to either a music or art class while taking into account the data we collected in the pretest sessions so that the groups were balanced on the measures we had.

Music and Art classes

Children attended six weeks of art enrichment classes. The music class was designed as a developmentally appropriate music enrichment experience and included singing, playing simple instruments, dancing to recordings, and learning rhymes, fingerplays, and lullabies. Parents were encouraged to use the materials from class at home. During the art classes, we created a rich environment with lots of art supplies and encouraged parents to play freely through art projects with their children. We also provided a new project each class that children could choose to work on.

Post-test

Children participated in a day of assessments to observe possible effects that the creative arts classes may have had on geometrical, numerical, and verbal reasoning skills. Assessments included: (1) a test of geometrical reasoning, (2) a test of map use, (3) a test of numerical estimation, and (4) a vocabulary test (PPVTb). Additionally, each parent completed a questionnaire, and we interviewed each child about his/her experience.

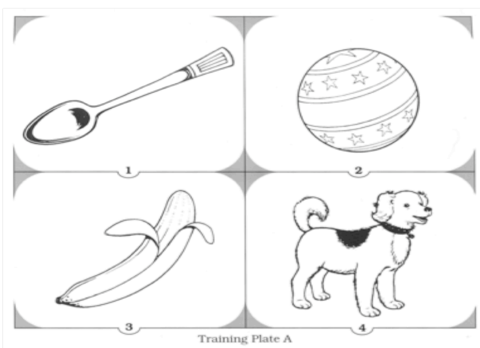
The geometrical reasoning and map tests probe the development of two distinct kinds of spatial reasoning. In the geometrical reasoning test, children viewed six geometrical figures that differed in size and orientation. Five of the figures shared a single property not shared by the sixth; we asked children, "Which one is different?". In the map test, children were shown a simple map depicting one of three geometrical forms (line, right triangle, or isosceles triangle) and were instructed to put a toy in a corresponding physical array of 3 containers (10 times larger than the map). Maps were rotated 90, 180, or 270 degrees for each trial; thus, to find the correct location, children needed to infer location from the geometry of the layout figure.

The numerical estimation test probes large, approximate numerical comparison: the ability to approximate cardinal values of large sets of visual information (i.e., dots). Children were presented with "Grover's dots" and "Big Bird's dots" and were asked, "Who has more?" The ratio of each character's dots was varied from trial to trial from easy (large ratio) to hard (small ratio).

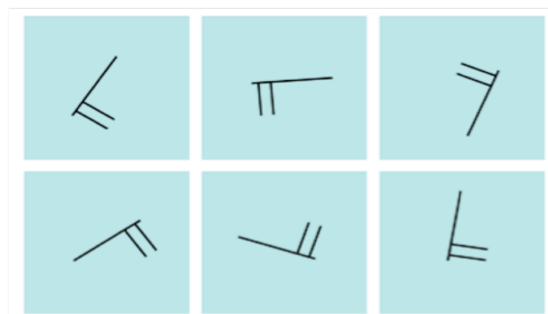
The PPVTb is a measure of receptive vocabulary, words that children can recognize and identify, but not necessarily speak spontaneously. The child interviews and parent questionnaires provided us with information about how children and parents felt about their classes so that we could assess whether the two classes were comparable.

Children in both classes performed equally well on the numerical estimation and the PPVTb vocabulary test. However, significant differences in performance were found on the other two tests: the art class outperformed the music class on the geometrical reasoning test, while the music class outperformed the art class on the map test.

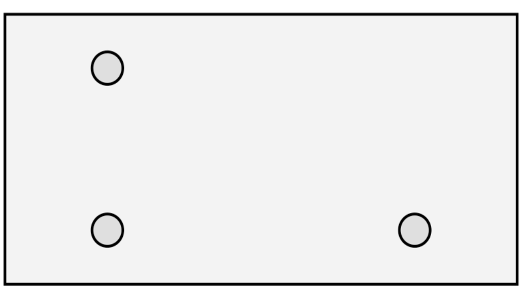
Further data analysis is still in progress. We are interested in attempting to determine what underlying mechanisms caused these differences in task performance. We would like to say a big thank you to all our study participants. Stay tuned for our conclusions!



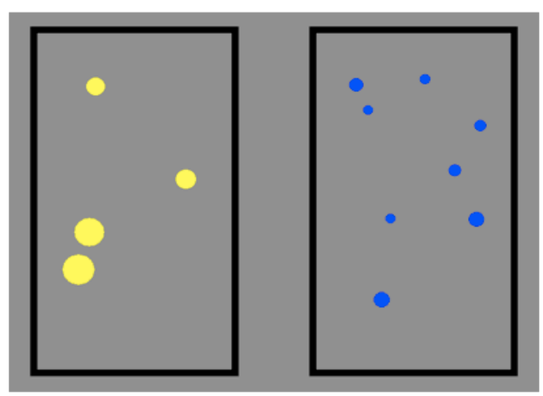
An item from the PPVT-iiia test. The child is asked, "Can you point to *dog*?"



An item from the geometrical reasoning test. The child is asked, "Which one is *different*?"



A map from the map test. The experimenter gestured to a circle on the map and asked the child to place a toy on that spot. The circles corresponded to an array of buckets ten times larger, on the floor in front of the child.



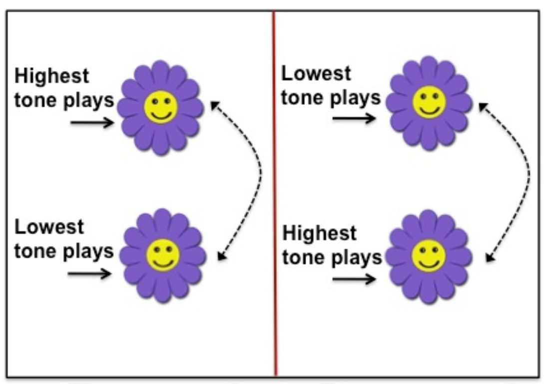
An item from the numerical estimation task. Big Bird's dots are on the left; Grover's dots are on the right. The child is asked, "Who has more dots?"

Music and Space

Rachel Katz, Researcher

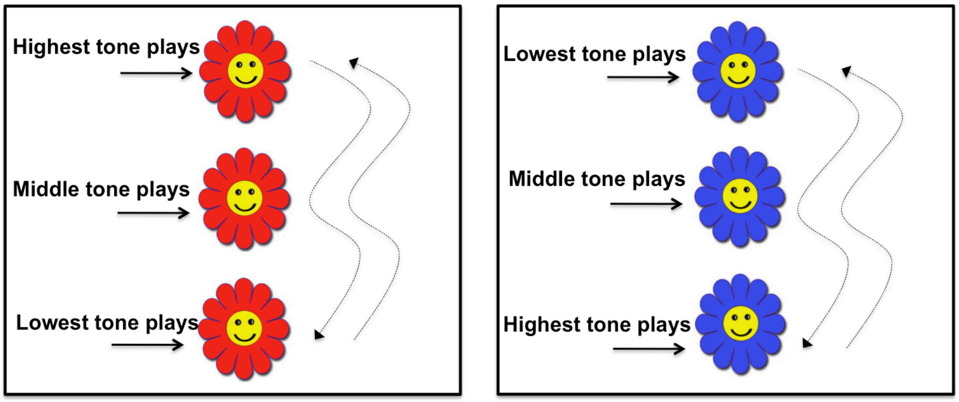
We often use spatial metaphors to represent dimensions that are not spatial in nature. For example, in the domain of music, we speak of tones being "high" or "low" in pitch. This study investigates whether infants share this same intuition. Previous studies in our lab have shown a connection between music training and spatial abilities but the origins and development of this association are unknown. Past studies have also shown that adults link changes in pitch to changes in height, suggesting that we may represent sounds in various spatial positions when we hear a melody or tone sequences. There is also evidence that infants are sensitive to this relationship as well. This study explores the origins of the association between musical and geometrical processing in four-month-old infants. We are interested in whether infants can detect relationships between sequences of musical tones and sequences of spatial positions.

In the first study condition, we presented infants with movies in which a flower danced in two vertical spatial positions (high or low) while sequences of musical tones played. Flower positions and tones were presented in either a forward pairing in accord with the pitch/height relation that adults judge as congruent (the flower appeared in the low position when the lowest tone played and the high position when the highest tone played) or a reversed pairing (the flower appeared in the low position when the highest tone played, and the high position when the lowest tone played). We were interested in whether infants preferred the forward pairing of tone and space over the reversed pairing. We found that infants looked equally long at both pairings, suggesting that they may not have an inherent preference for a particular type of pairing.



Forward Reversed

Next, we were intersted in whether infants would find it easier to learn the forward pairing of tone and space than the reversed pairing. In the second study condition, one group of infants was shown movies of flowers dancing in three vertical positions (high, middle, low) in time to three-note sequences presented in the forward pairing. A second group of infants was presented with the reversed pairing of tones and flower positions. When infants were no longer attentive to these movies, both groups saw the same test movies shown to infants in the first study condition. We found that infants preferred to look at the forward mapping of tones and flower positions only when they were familiarized to this forward pairing beforehand. Infants who initially saw the reversed pairing of tone and space did not show a preference for either the forward or reversed pairings during the test movies. This suggests that although infants may not show an intrinsic preference for the forward over reversed pairing of tone and space, they do distinguish forward from reverse mappings and are predisposed to learn the forward mapping of tone pitch and height over other mappings.



Forward Mapping   Reversed Mapping

In the third study condition, we wanted to know whether infants continue to perceive a relationship between tone and space when these two types of information are presented separately. Infants initially heard either ascending or descending five-note sequences without any corresponding spatial display. They then watched movies with purely spatial information, in which a flower moved silently up and down on the screen, with no accompanying music. We hypothesized that if infants automatically map spatial and tone information congruently, then if they initially heard one pattern of musical tones (for example, ascending notes), then they should prefer to look at a novel pattern of spatial movement (for example, descending flowers). Contrary to our predictions, infants looked equally long at both events. These experiments suggest that four-month-old infants' ability to relate music to space is starting to develop, but their sensitivity to this relationship is fragile.

Toy Choice & Learning about People

Rachel Katz, Researcher

What influences infants' early social preferences? Previous research suggests that infants' and children's preferences are driven by factors such as language (e.g., native language vs. foreign language), gender, and race. However, little research has been done to explore the origins of gender- and race-based social preferences in infancy. Over the past year, three lines of work were designed to investigate these questions.

The first two lines of work investigated infants' attention to gender and race when deciding on their own object preferences. In the first line of work, we explored whether infants use gender when engaging with different objects. Previous research has found that infants show a visual preference for faces of people whose gender matches their primary caregiver. However, little research has been done to investigate whether these visual preferences indicate social preferences. In order to further investigate the social factors that influence these early preferences, we tested whether infants' attention to gender had an affect on their desire to engage in social interactions.

During the study, 10-month-old infants watched short video clips featuring a friendly male and female actor speaking a series of phrases. After each actor spoke, both simultaneously held up identical toy animals and offered the animals to the infant by extending their arms forward. At the same time, a "magical" bar moved onto the table in front of the infant. The same toys featured in the video clips were attached to the bar, thereby creating the illusion that the toys being offered in the video by the actors were the same toys that now appeared in front of the infants on the table. Infants were then given the opportunity to reach for the toys, and reaching behaviors were analyzed. We found that infants did not show a robust preference for the toy offered by either the male or female actor. In addition to analyzing reaching behaviors, we also coded infants' emotional and behavioral reactions to the videos as a measure of their social preferences. Specifically, we rated how happy, distressed, engaged, and bored infants were in response to the male and female actors and coded the number of times infants smiled to both individuals. We found no significant differences in emotional reactions based on gender. These findings suggest that gender may not be a factor that influences infants' social preferences at this age.

In our second line of work, we tested whether 13-month-old infants attend to race information when accepting toys from adults. Previous research has revealed that infants look longer at same-race compared to other-race faces, but it is unclear whether these looking patterns reflect social preferences. In order to further explore infants' preferences in relation to race, we presented 13-month-old infants with a toy choice task designed to assess their social preferences in a live interaction with novel same- and other-race individuals.

During the study, infants were introduced to two male actors, one of whom was white and one of whom was African-American. Initially, each actor asked parents a set of questions (for example: "What is your child's favorite book?") and then offered infants a series of toys. Infants were given the opportunity to reach for these objects, and we measured infants' reaching behaviors as an indicator of their social preference. We found that infants were equally likely to choose toys from the white and African-American actors, suggesting that infants do not show race-based preferences at this age. These findings differ from previous studies of older children in our lab who, at least by the age of five, demonstrate same-race preferences.

In a third line of work, we studied 5-month-old infants' spontaneous emotional and behavioral reactions to novel individuals differing on race and gender. During the study, infants watched videos of white and African-American female and male actors (four in total). Each actor spoke five phrases in an infant-directed way and we judged infants' happiness, distress, engagement, boredom, and the number of times they smiled during each of these clips. Actors' race and gender did not seem to influence infants' emotional reactions to the videos, as there were no observed differences across the clips.

These three studies preliminarily suggest that infants may not use gender or race to guide their social preferences. We are currently running and analyzing data from follow-up studies (e.g., ones that feature people speaking in infant-directed vs. adult-directed speech) that might help us to better understand what these results can tell us about the factors that do drive infants' early social preferences.

Music and Friendship Preference

Gaye Soley, Graduate Student

Children evaluate others based on many different cues like gender, age, race and language. Music is a potential cue to social group membership, since it is a universal activity with culture-specific features. Our previous studies show that music also influences children's preferences for others. For instance, 4 and 5-year-old children prefer children whose favorite songs are familiar to them. Moreover, these preferences seem to be driven by sensitivity to shared knowledge. For instance, whereas children prefer others who like songs regardless of whether the songs are familiar or not; they prefer others who know familiar songs, and who don't know unfamiliar songs. Given that shared knowledge of songs is a more reliable cue than emotional responses to songs in terms of social group membership, this early influence of shared knowledge on social preferences suggests that children are sensitive to markers of social group membership.

Right now, we are further exploring the role of shared knowledge and shared preferences in children's understanding of social categories.

We are testing 4 and 5 year old children. Children are introduced to a picture of a child (a girl or a boy) on a computer screen and they are presented with a song that the child on the picture either knows or likes. We then introduce them to two other pictures that differ in terms of gender. Then, we ask children who is more likely to know or like the same song. Children receive eight trials. On each of the trials, they are introduced to different pictures of children.

We're still in the process of analyzing our data, but we do have some interesting results to share! We see that children are more likely to choose the same gender pictures as the sample picture when asked about shared preferences and also when asked about shared knowledge. We also hope to ask the same questions using a different social category like race.

Music and Social Preference

Gaye Soley, Graduate Student

Previous research shows that infants show a striking preference for the structures of their native culture, such as their native language, faces of their own race, and even the music of their own culture. Moreover, after watching two individuals speak in different languages, 5-month-old babies prefer to look at the person who previously spoke in their native language.

These results suggest that the early preference for familiar structures may serve important social functions such as directing attention towards the caregiver or identifying the members of one's own social group.

Music is an important aspect of early infant-caregiver interaction and it is part of every culture. In a set of studies, we asked whether musical stimuli would guide infants' attention towards individuals. We tested five-month-old babies on their parents' lap in a dimly lit testing room with one screen located in front of the infant. Parents listened to classical music through noise-canceling headphones so that they wouldn't influence their babies. We presented babies with alternating films of two women singing familiar or unfamiliar music. Before and after showing these videos, the two women appeared side by side on the screen, silently smiling at the infant, and we coded how long the baby looked at each person during these silent trials in order to infer preference.

Our results showed that after listening to each woman sing, infants preferred to look at the singer of the familiar song compared to the singer of the unfamiliar song. We are currently running a new study, where the two actors clap to different songs. This study will help us understand whether producing the music is necessary in order to elicit preferences for the individuals.

This early influence of music on infants' looking preferences for individuals provides support for its' biological and social significance.

Helping in Absence

Lauren Kleutsch, Lab Coordinator; Elsa Loissel, Nicole Grifka; Research Assistants

A number of studies have shown that during children's second year of life, they begin to act prosocially in a variety of ways, including acts of helping, comforting, and sharing. However, most of the past research showing prosocial behaviors in young children used scenarios in which the recipient provided overt cues about the problem. For example, the experimenter is desperately reaching for an object or is struggling to open something, making sounds of effort or even asking the child for help directly. But do children really need all these cues that the helpee provides in order to realize that help is needed? Perhaps they can infer that from the situation alone. Therefore, in this study, we tested whether young children (aged 21 months and onwards) would help another person proactively, that is in the absence of behavioral cues from the experimenter. To do this, we created a situation in which an actor doesn't even notice that an accident occurred (in this case, an object drops on the floor while the experimenter is turned away, engaged in another task). This was contrasted with a control condition in which the experimenter made the object fall on the floor on purpose. We then analyzed the results to see how often children helped by picking up the fallen object. We found a strong age effect, such that children aged 21 to 23 months helped only rarely, while children from around 24 months onwards helped reliably by either lending a hand or informing the agent about the problem. These results suggest that explicit behavioral and communicative cues are not necessary in order to elicit help from children, and that instead, at least children aged two years and older help proactively, not only reacting to another person's expression of need.

Helping and Preferences

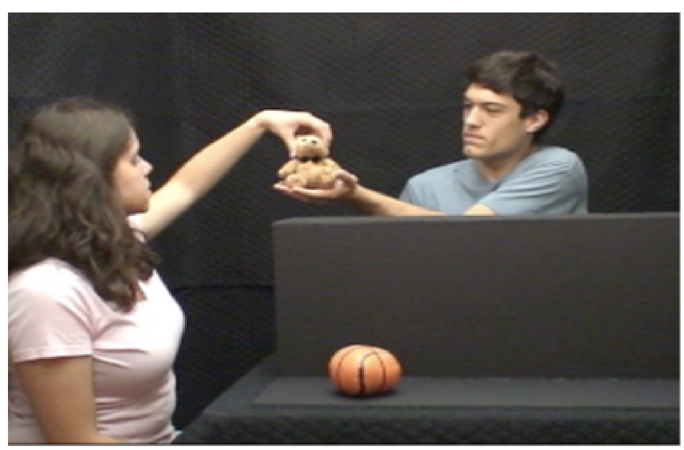
Kathryn Hobbs, Graduate Student; Alexandra Dowd, Thesis Student

An astounding finding has emerged recently: babies may evaluate others' actions morally, preferring those who help others to those who hinder others. This is a strong claim, one that requires a great deal of background knowledge on the part of infants, including an understanding of goals and helping. In this study we seek to ask just how infants think about goals and how they relate to helping. That is, do infants infer preferences for objects on the basis of people's actions and expect others to help by giving someone their preferred object?

Infants do reason about others' actions in terms of goals. If they see an actor with two objects in front of her and she always reaches for a particular one, they are not surprised when she reaches for that same object again, even when it is in a new location. Following up on this finding, will infants expect someone to give an actor her preferred object when there are two options available?

To test this we used the standard procedure described above but with an alternative ending. Infants see one person reach for one of two objects (a bear or a ball) until they get bored with this scene. In the test trials, the other actor hands the first person one of the objects—either the same one he previously reached for or the other one he had always ignored. We measure how long infants look at these two types of events to see which one they find more surprising or unexpected.

Both 6- and 9-month-old infants seem to have no expectations about how this helper should behave, as they look equally long on average at the two test outcomes. This is a surprising result, given that infants seem to have a strong understanding of people's goals at this same age. We are conducting a follow-up control study to make sure this is the case with our particular study. It may be then, that infants don't yet understand helping in the same way we do; maybe they thinking giving things to people is just nice, regardless of what people like. The next step will be to probe this developing understanding of helping further to determine when and how it emerges.



Desire Understanding and Helping

Kathryn Hobbs, Graduate Student

By about 14-months, infants seem to be genuinely helpful creatures. They often bring us toys and other things to show us, and will even help us when we can't reach an object. Of course, many parents report this all changes when the "terrible twos" roll around! But even if infants don't want to be helpful they still may know how to be helpful. This study begins to explore what infants know about how to be helpful.

One thing that is required to be most helpful is to consider what your social partner's preferences are. If your friend is hungry and prefers goldfish crackers to broccoli, giving her broccoli is nice enough, but not as helpful as giving her some goldfish would be. To be helpful, one must both understand this principle, and be able to figure out what a social partner's preferences are. Previous research has shown that by 18-months of age infants can figure out which of two food item someone likes based on their emotional responses to each, and will give the person their preferred food. That research found, however, that 14-month-olds had trouble giving the adult her preferred food—instead they usually gave their own favorite food. But in that study, the adult's preferred food (usually broccoli) was always in conflict with the infant's own preferred food (generally goldfish crackers). Perhaps the 14-month-olds' results were a reflection of this conflict; we wondered, would 14-month-olds be better helpers in a task that didn't contain this difficult element of conflicting preferences?

To examine this question, we've started by studying 18- to 20-month-olds and will try the study with 14-month-olds (assuming we find success with this first age group). Infants see an actor show a preference for one of two toys by reacting neutrally towards one and very positively towards the other. Specifically, the actor showed a neutral facial expression while holding one object and said for example "oh, hmm, a ball. Yeah, well, I like this one okay" in a flat tone of voice. With the preferred object, however, the actor smiled at the toy and said "oh, wow! A block! I really like this one!" in a positive tone of voice. In the test trials the actor clumsily knocked both toys off the table and out of his reach, necessitating help from the child.

While this study is still in the early stages, there are some hints that 18-month-olds at least understand something about emotions and preferences and what it means to be maximally helpful. On the first test trial, almost all children help the actor by bringing him/her the toy s/he responded positively to. The next step for this project is to run the study with more 18-month-olds to get a better idea of their abilities, and then perhaps run it with younger infants.

Pragmatics and Prosody

Noemi Hahn, Researacher

Understanding utterances involves more than just understanding the meaning of the words and the grammatical structure of the sentences. Often times we also need to go beyond the literal meaning of an utterance and figure out what it implies in a particular conversation. For instance, if we hear the following sentence: What nice weather! in the middle of a thunderstorm, we need to realize that the intended meaning of the sentence is just the opposite of its literal meaning. This skill is called pragmatics. Another cue that can help us figure out the intended meaning of this sentence is how the speaker says this sentence. If the speaker uses a negative (sad or angry) intonation, then we realize that what he/she meant is how bad the weather is. The melody or intonation of a sentence is called prosody. The above-mentioned examples, however, are only small parts of these skills. Both pragmatics and prosody can serve our everyday communication in many different ways, which might be relatively independent from each other. While we know little about how these different aspects develop relative to each other in typically developing (TD) children, the ultimate goal of our study is to find out which of these different aspects are impaired and which ones are spared in autism spectrum disorders (ASD), where the deficit in communication is a key characteristic. In order to find these potential differences within these two skills, we tested 6-to 9-year-old children – both TD children and children with ASD – on a battery of five studies.

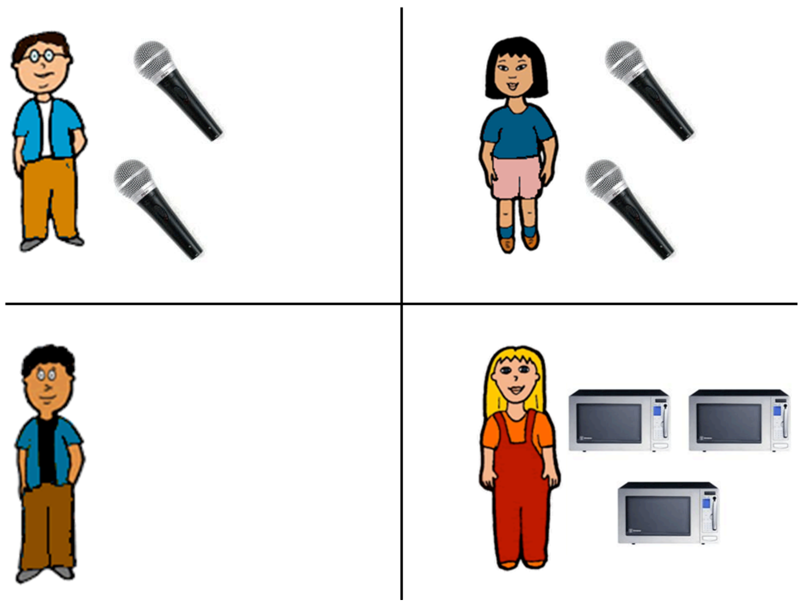
1. The animal game

Figuring out what a pronoun refers to in a sentence is another pragmatic process that is sensitive to a wide variety of factors. Pronoun errors are frequently reported in the production of children with ASD. However, there is very little existing evidence about their ability to interpret pronouns in an experimental situation, especially with children with ASD that have no language impairment. In our first study, children are listening to sentences with ambiguous pronouns while looking at the screen with the three characters mentioned in the sentences.

For instance: (1) Sheila (the sheep) visited Ellie (the elephant) and she called Henry (the horse). (The children learn the names of the characters before the study). If children can follow the discourse of the sentence, then they will know that the ambiguous pronoun she refers to Sheila, and they will look at this character, since she was the subject in the first part of the sentence and the pronoun is in the subject position in the second part of the sentence. There is a special case though, when she can refer to Ellie, and it is when the pronoun is stressed. (2) Sheila (the sheep) visited Ellie (the elephant) and SHE called Henry (the horse). Stress is a prosodic cue (just like the sad/angry intonation in the introduction). In this case, prosody is used to emphasize contrast: the pronoun doesn't refer to its usual, default referent (Sheila), but to the other female character in the sentence (Ellie). We expect that TD children will be able to resolve pronouns in the subject position and will be sensitive to the contrastive stress. If the reported difficulties with pronouns in ASD are due to the children's additional language impairment, then we expect that highly verbal children with ASD will be able to resolve ambiguous pronouns and choose Sheila as the referent in sentence (1). However, if these errors are due to the inability to follow the discourse context, then they won't be able to choose the correct referent. Moreover, if they are sensitive to the prosodic cue in the sentences with the stressed pronoun, they should choose the second-mentioned female character in the sentence (2).

2. The girls and boys game

Our second experiment aims at exploring how certain pragmatic interpretations are generated, by focusing on how people process words that refer to quantities like some, all, two, and three. In particular, we focus on sentences like "A girl has some of the microphones," which is logically consistent with a situation where she has all of the microphones (the total set), but is often interpreted with an inference that implies that she doesn't have all of them (a proper subset). This is because we as listeners assume that if the speaker wanted to refer to a girl with a total set of the microphone, he/she could have said all instead. Thus, if children generate these pragmatic inferences just like adults when they hear the sentence "There is a girl who has some of the micro…phones," they will look at the girl with only 2 of the 4 microphones (subset) even before they hear the word phones. (More details about this study can be found in Newsletter 2010.)



We expect that TD children will generate this pragmatic inference, in which case we might find one of two different responses with kids with ASD: 1) they might generate the inference, suggesting that this aspect of pragmatics is intact in the disorder, or 2) they might fail to generate the inference, which suggests a delay in this pragmatic skill.

3. Last object game

It has been long debated whether children with ASD can use contextual information. Some studies find that they have difficulties with processing global information, but are good, and sometimes even better than TD children, at processing small bits, such as single words. In our third study we examine how children interpret homophones: words which have two meanings, e.g. bat. Bat can refer to the animal bat or the baseball bat. In some of our sentences there is a contextual cue before children hear the homophone. E.g. John fed the bat that he found in the forest with his mom. The verb 'fed' helps the listener realize that the homophone 'bat' refers to the animal in this case and not to the baseball bat. We examine whether children can use this contextual information by recording children's eye-movements to a display where one of the 4 objects was in association with the other meaning of the homophone, baseball bat. This object was a baseball glove (the other 3 pictures were unrelated to the homophone).

4. The Nice vs. broken game

As mentioned in the introduction, prosody can be used to express the speaker's emotional state. This type of prosody is especially crucial when the meaning of a sentence is ambiguous. In this study, children are presented with 2 pairs of pictures while they are listening to sentences with a happy or a sad tone, e.g. "Oh, look, my bike". Each pair shows a nice/intact version of an object and a dirty/broken version of it. In order to select the correct picture, children need to integrate the affective prosodic cue in the sentence with the linguistic information.

If they don't use prosodic information, such as a happy or a sad tone, they won't know if they should pick the nice or the broken version. But if they don't use the linguistic information, they don't process the noun in the sentence and they won't be able to choose between the two objects (flower or bike). Based on earlier studies we expect that 6-9 year-old children will be able to integrate these two cues and choose the correct referent. However, earlier studies and observations show that kids with ASD do have difficulty with attributing emotional states to others, a part of which is using affective prosodic cues. But it is not clear why they have this difficulty. If they are unable to use affective prosody entirely, they won't look at the matching pictures before the noun. For example, if the sentence is "Oh, look, my bike" in a sad tone, unlike TD children they won't look at the two possible pictures, nor will they look at the two broken referents: the second (broken bike) and the third (broken flower) pictures, before they hear "bike". However, if they have problems with integrating the affective prosodic cue with the linguistic information, they will reduce the possible responses to the two broken objects before "bike", but won't be able to choose "bike" after they hear the noun. We hope that with this study we will be able to distinguish between these possibilities.

5. The robot game

Prosody can also be used to figure out the speaker's intended structure of the sentence. To understand what someone says, a listener must identify individual words and then group them into meaningful units to determine the meaning of the whole utterance. Since the typical speaker produces about 3 words per second, we have to do this very quickly. Combining the words in different ways gives us different interpretations of the meanings of the sentences we hear; however, sometimes by the end of the sentence it becomes clear which interpretation was correct. In our fifth study we examine if children with ASD are capable of using prosodic cues such as pause in order to find out what the intended structure of a sentence is, as soon as the prosodic cue is present. Take one example:

(1) "While the robot dressed… the nice cookies baked." or
(2) "While the robot dressed the nice baby… the cookies baked."

This is a temporarily ambiguous sentence: until the object 'cookies' or 'baby' is presented, one can interpret it in two different ways if the words are combined differently. When children listen to this sentence, they need to figure out which of the two interpretations is correct using prosodic cues, such as intonation and pause. For example, if children can use these prosodic cues, then they will expect a new sentence when they hear the pause after 'dressed'. Thus, they are more likely to look at 'cookies'. In other words, when an animate and inanimate object are presented on the screen, a prosodic pause after the verb 'dressed' will result in expecting, and therefore looking at, an inanimate object (something that cannot be dressed). Vice versa, when there is no prosodic pause after the verb 'dressed', this will result in expecting an animate object, or something that can be dressed. Since in this study, prosody is applied to understand the grammatical structure of a sentence and not necessarily what the speaker's intention or in general his/her mental state was, we expect that children with ASD, just like TD children at this age, will be able to use pause as a prosodic cue to combine words in the appropriate way and thus to disambiguate the sentence early on.

Thank you so much to all the families who have participated. None of our research is possible without your support. If you have any questions, want to refer a friend, or would like to participate in more research, please get in touch with us!

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