S P R I N G
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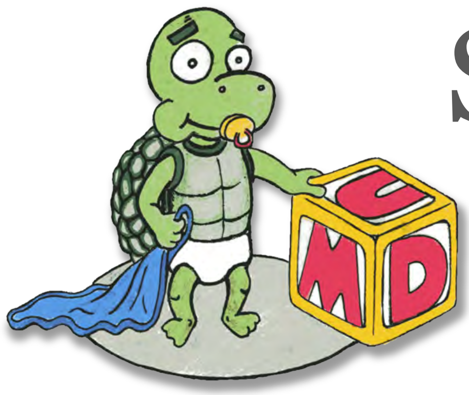
INFANT & CHILD STUDIES



@ THE UNIVERSITY OF MARYLAND

We're always recruiting!

The Infant and Child Studies labs welcome new and returning families for a range of studies on child development.

Please contact us if you are interested, and pass the word along to families and friends with children as well!

We have studies for children from 2 months to 18 years!

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PSYCHOLOGY

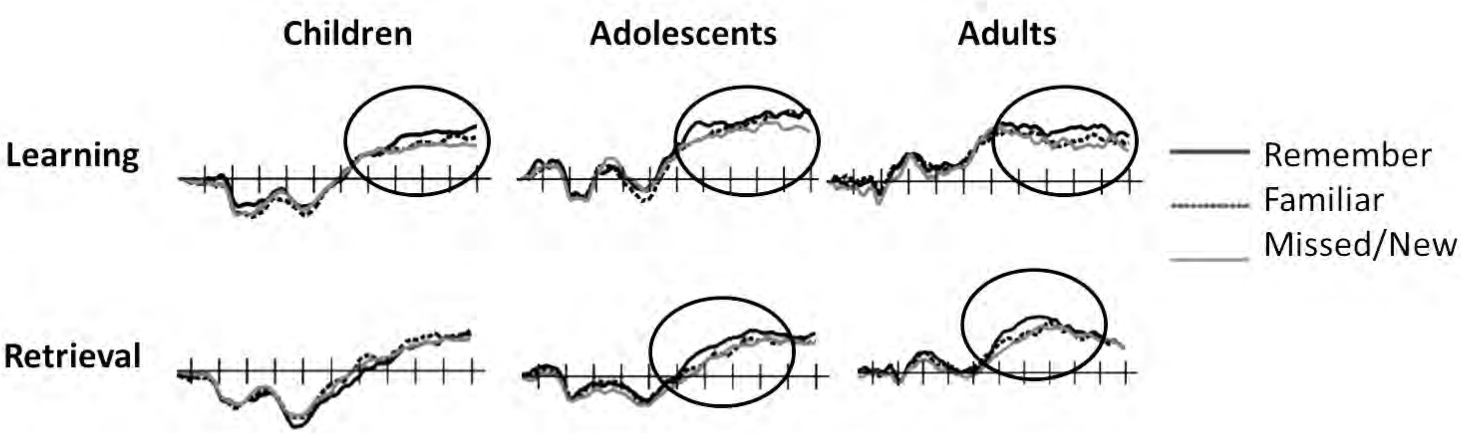
The development of *remembering*

Try to think about your first memory and how old you were when you experienced this event. Most of our first memories are associated with events that we experienced when we were 3 to 6 years of age. The inability of most adults to recall any memories from infancy is referred to as infantile amnesia. Although we can remember events from early childhood, the quality of our memories improves with the age we were when the event occurred. For example, a memory for an event that occurred when you were 12-years-old is more likely to be associated with contextual details (e.g., who was present, where the event occurred, when it occurred) than an event experienced when you were 6-years-old.

The goal of this project was to identify how brain development was related to the subjective experience of remembering in children, adolescents, and adults. We assessed age-related changes in how participants learned as well as retrieved information from memory. It was possible that improved memory across childhood would be associated with the development of learning processes, retrieval processes, or both learning and retrieval processes.

We investigated this question with 6.5-8-year-old children, 12-13-year-old adolescents, and adults. Participants saw pictures of red and green living and nonliving everyday items and animals on the computer screen. For each item, participants told us what color the item was and either made a living/not living judgment or a small/big judgment. Later we showed them all of the pictures again in grayscale. We asked them if 1) the picture was "remembered" or just "familiar," 2) if the picture was originally red or green, and 3) which question they originally answered about it (i.e., "did you say if it was living or if it was big?"). Some participants had brain activity collected while they learned the information whereas other participants had brain activity collected while they retrieved the already learned information.

Our data showed that memory for pictures and their contextual details (i.e., item color and the judgment made at learning) increased with age. Brain activity helped us determine whether this improvement in memory was associated with the development of learning and/or retrieval processes. Children, adolescents, and adults showed similar brain activity during the learning phase of the study. Brain activity was more positive to "remembered" (solid black line) than "familiar" (dotted black line) or missed (gray line) pictures. In contrast, there were age-related differences in brain activity at retrieval. Similar to other studies in adults, adults had brain activity that was more positive to "remembered" (solid black line) than "familiar" (dotted black line) or new (gray line) pictures, and this response was focused over one brain region. Adolescents showed a similar pattern of brain activity, but this response was more widespread than it was in adults. Children did not show this pattern of brain activity at all. This suggests that memory improvement between 6.5 years of age and adulthood is mostly due to the development of memory retrieval.



New research initiatives at UMD

Most of our research at UMD focuses on typically developing children. But we have been expanding in recent years: we now have studies exploring how language learning differs in children raised monolingually vs. bilingually, how learning and attention differ in children with autism spectrum disorders or other developmental disorders, how to bridge the disparities in language abilities between children from high and low socio-economic backgrounds, how well children with cochlear implants or hearing impairments can understand and learn from the language surrounding them, and even how a child's language can be affected by getting a concussion! To find out more about these studies, please visit our website, like us on Facebook, or simply call our labs!

What is he feeling?

How do you know what another person is thinking or feeling? The ability to understand others' thoughts, beliefs, and desires (or mental states) changes dramatically throughout childhood. As children develop, they get better at thinking about what other people are thinking and feeling. Childhood is also a time when the brain itself changes and matures. Previous research suggests that the amygdala, a brain region often associated with emotion understanding, plays an important role in understanding other's thoughts and feelings. We are interested in understanding how development in the amygdala is related to this developing social understanding. We also are interested in whether amygdala differences in adults would account for differences in their ability to make social judgments. These findings can also help explain how atypical development of this region is related to the social difficulties typical of autistic individuals.

To examine the amygdala's role in understanding others' thoughts and feelings, child (ages 4 and 6) and adult participants came in for two sessions. In one session, participants completed a task, called "Mind in the Eyes", where they viewed images of adults' eyes and had to choose from different mental state descriptors to describe the images. These descriptors were adjusted for the age of the participant. For example, adults would see words such as "flirtatious" or "contemplative", while children would see words like "joking" or "not believing".

Participants also completed story-based tasks, which involved reasoning about other people's thoughts and feelings. In the other session, participants underwent a functional magnetic resonance imaging (fMRI) scan, which uses a strong magnet to create images of the brain.

Once both behavioral and imaging data were collected, we examined the size of each participant's amygdala relative to the overall size of their brain. We then compared the size of their amygdala to their performance on the "Mind in the Eyes" task. We found that larger amygdala size was related to better performance on the "Mind in the Eyes" task in both children and adults. Amygdala size was not related to performance on any of the story-based tasks. This suggests that the amygdala may be involved in inferring people's thoughts and feelings from their faces, specifically their eyes. These findings help us to understand how brain changes during child development are related to children's increasing social abilities, and may also help us understand some of the social difficulties faced by children with autism.

Understanding social goals

Young children often take immense pleasure in being helpful to others. Drop a pen on the ground, and a 14-month-old will instinctively pick it up and hand it back to you. Spill a bunch of quarters, and an 18-month-old will help you clean them up, sticking with the task until it's done. If you're looking for your keys and a toddler saw them fall under the table, she may use a finger point to helpfully inform you about their new location. Many recent studies have explored children's responses to situations such as these, documenting a strong impulse to act prosocially as early as the second year of life.

Dr. Jonathan Beier and the Lab for Early Social Cognition have begun examining children's responses to other people's frustrated social goals. Their research investigates developmental changes in how children between 18 months and 37 months of age understand and respond to the social goals of other people. For instance, if one person is trying to get another person's attention, will children helpfully bring the two people together? And, in this example, how do children tell the difference between a person who doesn't respond to somebody because she can't hear her versus a person who clearly does not want to be bothered?

For more information or to participate in this research study, contact the Lab for Early Social Cognition at socialkidslab@umd.edu

Studying the social brain

Children are very social, from the first smile in infancy to making new friends in middle school. Scientists are interested in which parts of the brain are responsible for this kind of social behavior. They call these areas the *social brain*. However, most studies of the social brain show children photographs or recorded videos. Does a child's brain respond differently to real social interaction?

The Developmental Social Cognitive Neuroscience lab (www.dscn.umd.edu), under the direction of Dr. Elizabeth Redcay, is investigating this question in children ages 8-12. Children interact with one of our researchers while we collect brain responses. We collect our data using functional magnetic resonance imaging (fMRI), which is a safe procedure that uses a large magnet to take pictures of the brain. We recently finished investigating this question with a group of adults, and we learned how the brain responds differently to a live interaction—and now we're learning more about how the social brain looks in kids.

This research will help us understand how the developing brain responds to real-world interaction. We also hope to extend this work to autism, since this type of interaction is often an area of difficulty. We are excited about this study and we hope you are too!

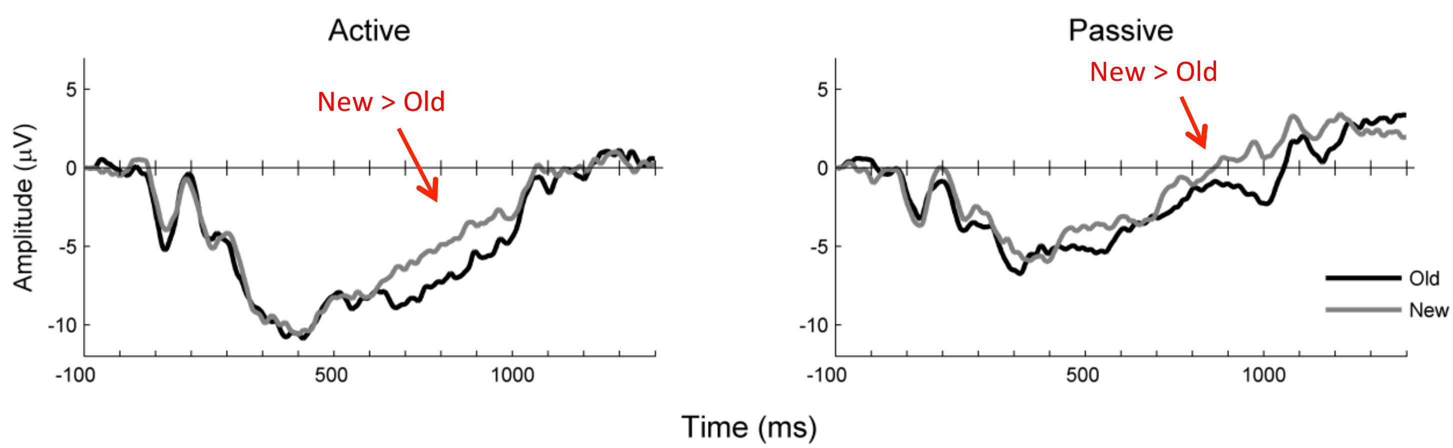
Does your brain experience memories even when you are not trying to remember?

We often put forth great effort to try and remember something, such as where we left our keys or the last item on our grocery list, but sometimes something in the environment can cause a memory to pop into our minds involuntarily (such as a smell that reminds you of your Grandmother's kitchen). Our lab has been working to figure out if memories that are *passively* activated are treated the same by our brains as memories that we *actively* try to retrieve.

To compare the brain's response to *actively* & *passively* retrieved items, 4- and 5-year old children came to the lab and played with numerous toys with an experimenter. Then, the children's brain activity was recorded while they viewed pictures of both toys they had played with and new toys. In one group, children were asked to *actively* remember by saying out loud whether the toy was one they had played with before or not. In the other group, children were not asked to do anything except *passively* view pictures of the toys. After brain activity was recorded, this second group of children was then presented with both the old and new toys and asked to identify which they had played with before and which were new.

Both groups of children were able to discriminate the old and new toys. We then compared brain activity between the children who *actively* & *passively* viewed the pictures. The overall pattern of brain activation was the same for both groups - different responses to old and new toys were apparent in both groups (see Figure). However, the overall amplitude of the response was greater for the *active* group. This pattern suggests that, yes, the brain does experience memories even when not *actively* trying to remember, but, the effort of trying to remember may give a "boost" to activity in general (see Figure).

We are now bringing children into the lab to see if children's memory for contextual details (such as where toys were located) can be both *actively* & *passively* remembered just like their memory for the toys. For more information, or to have your 4- or 5-year-old participate, please contact MarylandNCDL@gmail.com!



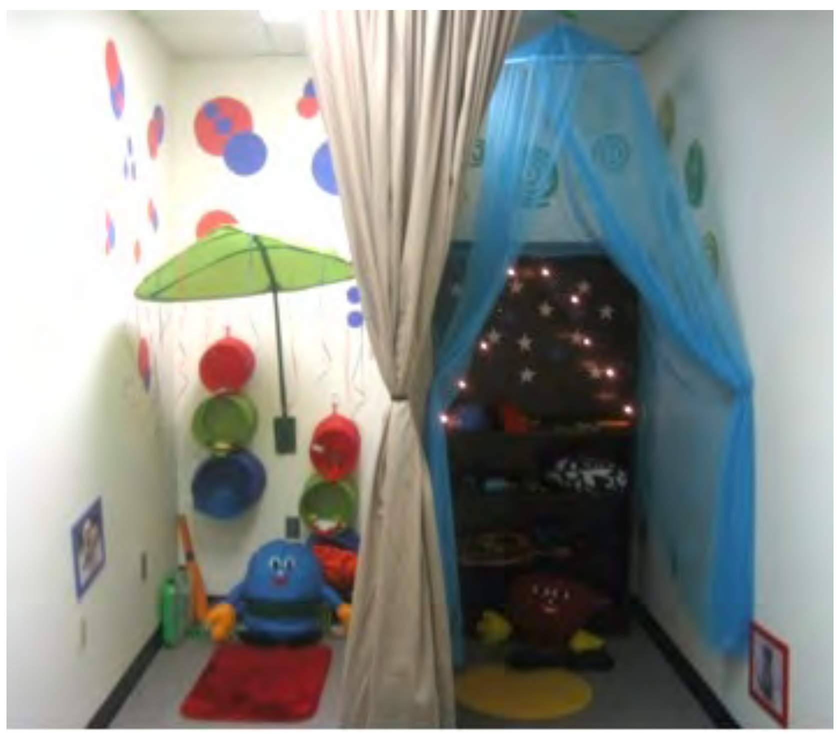
It's all in the details...

Have you noticed how much your child's memory has improved with age? As children get older they are better able to remember contextual details associated with events. For example, after attending a birthday party older children are more likely to remember details such as who attended a party, what games were played, and where the party was held. Our lab has been investigating how brain development is related to memory in early childhood.

To study children's memory for details we ask children to interact with toys in two different rooms (see picture). In addition, for each toy children learn a novel action associated with the toy (they either put it on their head, beat it like drum, or hug it). Later we show children some of the same old toys as well as some new toys. If they say they have seen the toy before we ask them 1) which room it belonged in and 2) which action we performed with it. Children's memory for the location and action improves with age.

In our first study we examined how brain *function* is associated with memory development in 3-, 4-, 5-, and 6-year-old children. To do this we measured children's electrical brain activity by having them wear an EEG cap (see picture!) while watching pictures of the toys. We compared children's brain activity to pictures of toys for which they remembered both the location and action to pictures of toys for which they forgot the location and action. With age, children had greater brain responses to items recollected with both details. In contrast, for toys where the details were forgotten, brain responses increased from 3 to 5 years and then were smaller in 6-year-old children. This pattern suggests that children's brains respond more specifically for memory for details with age! This more mature pattern of brain activity may be helping the older children remember more contextual details.

In another study we examined how brain *structure* is associated with memory in 4- and 6-year-old children. In this study we were particularly interested in how one brain structure known to be important for memory in adults, the hippocampus (see picture), changes in size during childhood and how size is related to improvements in memory. Children played the same game described above and completed an MRI brain scan during which we took pictures of their brain, including the hippocampus. As expected, 4- and 6-year-old children were able to identify which toys were old or new, but 6-year-olds correctly remembered more locations than 4-year-olds. When we related memory performance to hippocampal size, we found that larger hippocampi were related to better memory for location in 6-, but not 4-year-olds. These results suggest that the hippocampus undergoes developmental changes between 4 and 6 years, which likely contribute to improved memory for contextual details.



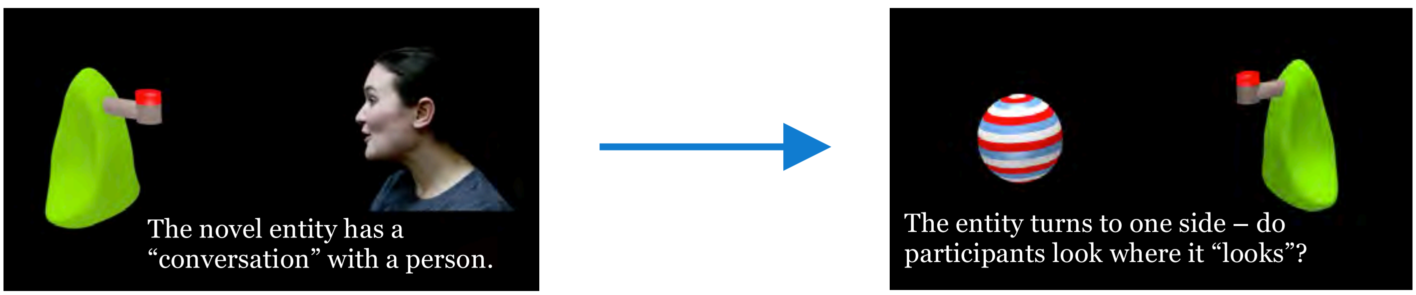
Don't forget to contact us with any questions: childstudies@umd.edu, visit our website: http://childstudies.umd.edu, or join us on Facebook: UMD Infant & Child Studies

Social responses to a novel entity's "gaze"

In our adult lives we easily distinguish between inanimate objects (like phones, computers, and refrigerators) and entities that are alive (like people, family pets, and other animals). One strategy for identifying living entities that we encounter the very first time is by its external appearance (does it have eyes, fur, or does it look like another animal that I already know about?). Another strategy is to observe the novel entity's behavior (does it exhibit self-propelled motion, does it seem goal-oriented in its behaviors, does it seem to be "looking" at things or interacting with others?). This second strategy can be helpful when the novel entity does not look very much like a familiar animal, or if our view of it is limited (for instance, if it is in the distance). In most circumstances, once we think that something is alive we are also inclined to think that it has mental states like desires and beliefs and some way of perceiving its environment.

Ongoing research in our laboratory uses eye-tracking technology to investigate how infants (19-20 months), children (4-6 years), and adults (18+) respond to a novel entity that does not look like an animal or human, but is capable of engaging with another person in a socially contingent interaction. Our primary question is: If we see a novel entity interacting with a person, do we then think of it as something alive, capable of holding mental states, and whose subsequent actions are meaningful?

Previous research shows that adults and children of all ages have fast, reflexive responses to the shifting eye gaze of other people, a behavior that happens so quickly it is not under conscious control. In our current studies, we measure the same response when participants view the novel entity turn to the left or right. Preliminary results suggest that adults quickly shift their attention toward a location where a novel entity is "looking" but that they only do this after seeing the entity interact with a person. That is, adults see the novel entity's interactions with another person as evidence that it is alive, and has a "gaze" that is meaningful. More tentatively, our results also suggest that this ability to is not as robust in infancy and may be undergoing significant development and maturation between 18 months and 6 years of age.



HUMAN DEVELOPMENT

Investigating links between action and interaction

Dr. Nathan Fox's lab has a new study with 7- to 10-year-old children! This study investigates how others' basic *actions* might develop into a complex understanding of social and human *interaction* (such as understanding other people's desires/thoughts, and how we cooperate/empathize). We are particularly interested in how a brain mechanism called the "mirror neuron system" might support developing links between *action* and *social* understanding.

Children come into the lab for two visits to play computer games. In one game, participants are introduced to two characters (a boy and girl), and have to guess whose hand is reaching based on the character's desires. For example, a participant might hear "The boy likes crayons," and then see a hand reaching for a box with crayons. If they answer correctly, participants would say that it's the boy's hand reaching!

At their first visit, participants play the game while wearing an EEG cap -- a special hat designed for kids that is made of small soft sponge sensors. The sensors record brain activity just like a microphone records sound! In the second visit, children play the same game while in an MRI scanner -- a machine that uses a large magnet to non-invasively take pictures of the brain! Kids get to practice playing with the MRI scanner first in our special warm-up scanner.

We have had a lot of interest in this study from families in the community, and our participants really enjoy seeing the MRI pictures of their brain!

Example of reaching images

Example of boy and girl faces

HEARING & SPEECH

Background speech

Children often find themselves in environments where multiple people are talking at one time. They may be at a crowded market, with their parent speaking to them amidst the sounds of many other people talking at the same time. How well can young children understand speech in these settings?

We have been studying different factors that might affect how well children can "ignore" background talkers. In many of our studies, children hear a voice telling them which of two different objects to look at ("Find the kitty!"). At the same time, another person speaks in the background. We have found that by the time children are 16 months of age, they are better able to listen to the main talker when the background speaker is of the opposite gender (that is, if a woman tells them to "Find the kitty!", they have more difficulty when the person talking in the background is also female than if that voice is from a male talker). In contrast, infants aged 8 months do not show this same effect of talker gender. And, somewhat surprisingly, even children aged 24 months do not find it any

easier to ignore a background talker who speaks in a different language. This suggests that children under 2 years are still developing the ability to listen "selectively", or to control who they pay attention to.

Currently, we are exploring whether children with autism spectrum disorders (ASD) may be delayed still further in this skill. Toddlers with ASD are at elevated risk for language delay or disorder, and some work with adults with autism suggest that they have particular difficulty recognizing speech in noisy, multi-talker environments. If children with ASD are also less adept at listening to one talker in the presence of background speech, this might limit their opportunities to learn language, and could help explain why these children are at such risk for language learning difficulties.

Nature and Nurture

One of the longest standing question in children's language development is to what extent language development is driven by abilities that children are born with versus the language that children are exposed to from the people around them. A large longitudinal study at the University of Maryland has been trying to unravel how these different components work together.

When talking to children, much of what we say consists of long, multi-word sentences, without any obvious breaks or boundaries. In order to learn new words, children have to take those sentences and break them up into individual words, a task known as "segmenting". Some children seem to be better able to segment speech as infants than are others (nature). But there are also things that parents can do to make the task easier: they could repeat words more often, or produce more single-word utterances (nurture). We have been looking at the combination of infants' ability to identify word boundaries and the type of speech they hear from their parents as a means of predicting later vocabulary size. We found that how well 8-month-olds can segment speech in a lab setting (their inherent skills) and the degree to which their caregivers typically repeat the same words to them at that age both contribute to the number of words they know at age two.

Assessing auditory processing

The Hearing Brain Lab, under the direction of Dr. Samira Anderson, recently began a new hearing study to examine central auditory processing in infants. Children with central auditory processing disorders have difficulty understanding speech and separating speech from background noise, and these problems may contribute to language and reading deficits. Early identification and treatment of central auditory processing deficits may produce long-lasting benefits for language and academic performance. Currently, identification can only be done through

behavioral measures that cannot be obtained until later childhood. We are using an objective test that measures the brain's response to sound through three electrodes that are placed on the top of the head, the forehead and on one earlobe. We play two sounds, "ga" and "ba", in the right ear through a little tip placed in the entrance of the baby's ear canal. The testing takes approximately 20 minutes, but we schedule two-hour appointments to allow time for feeding, calming, changing, etc. A benefit of the study is that the baby receives a comprehensive hearing evaluation.

LINGUISTICS

Children know more about "know" than you might think

How do three-year-olds understand verbs that refer to mental processes like "know" and "think"? These verbs are both used to talk about our beliefs, but they differ in subtle ways. For example, using the verb "know" can convey that we are more certain about a particular belief than if we were to use the verb "think". To convince someone that they need to take an umbrella with them, we might say "I know it's raining outside" instead of "I think it's raining outside".

We wanted to find out when children come to understand these verbs like adults do. Past research suggested that children do not distinguish "know" and "think" until they are at least four years old. Moreover, some researchers found that children still do not understand these verbs in an adult-like way even at the age of 11. However, the methods used in previous research struck us as unnatural and hence unlikely to tap into the sophistication of even a three-year-olds' knowledge.

We designed tasks using a much simpler games. In this task, we hide a toy in one of two boxes and ask the three-year-olds to find it. To help them find the toy, we give clues using "think" and "know". If the clue is "Lambchop doesn't think it's in the box", this might lead you to guess that it is not in the box, at least if you trust Lambchop. But, if the clue is "Lambchop doesn't know it's in the box," then you should guess that it is in the box. With this simple task, we found that many three-year-olds differentiate the two verbs in the same way as adults. This raises the question of how such young children learn the differences between similar verbs like "know" and "think"?

Who are you?

Pronouns can be complicated to learn, because their reference can change within a single conversation. For example, "I" can refer to me when I'm speaking, or to you when you are speaking. Anybody not present in the conversation can be referred to as "she" or "he". By exploring children's interpretations of pronouns in different conversational situations, we hope to find out how they cope with this kind of referential instability. We set up a game of finding blocks hidden in boxes, that your child will play with two researchers. The researchers use clues that are sentences with pronouns, talking either to each other, or directly to the child. By seeing which box the child chooses, we can get a better understanding of how children interpret pronouns in different types of speech.

Uncovering children's hopes

A new study explores the role of sentence structure in helping children learn word meanings, focusing specifically on the verb hope. This verb provides an interesting window into language acquisition for two reasons. First, unlike action verbs, mental verbs like hope describe aspects of the world that are removed from observation. An event of hoping does not have a characteristic shape in the world, unlike an event of jumping. Second, hope seems to share some characteristics of belief verbs like think or know and some characteristics of desire verbs like want, prefer or expect. We are exploring the role of sentence structure in helping children interpret verbs like hope. Belief verbs differ from desire verbs in the kinds of sentences they can occur in. We can say "Jeff believes that he is late" but not "Jeff wants that he is late." And we can say "Jeff wants to be late" but not "Jeff believes to be late." But hope can occur in both. We want to find out if children interpret hope more like a belief verb in "Jeff hopes that he is late" and more like a desire verb in "Jeff hopes to be late". If they do, it would suggest that sentences carry information that children can use in learning the meanings of abstract mental verbs like hope.

Learning verbs from conversation

In previous research, we have found that children as young as 16 months can use the sentence a novel word occurs in to make guesses about its meaning. Moreover, we have found that by 19 months old, children have expectations about the kinds of sentences that a verb is likely to occur in and that these expectations guide their comprehension processes, helping them understand sentences efficiently and learn new words. A current study examines the role of experience in building these expectations. Can we create expectations through exposure to small dialogs using unknown verbs? How much exposure, and of what kind, does it take to help children learn what to expect?

Verb knowledge is in place by 18 months

In English, different categories of words usually pick out different concepts – for example, verbs pick out kinds of actions whereas nouns refer to kinds of objects. In this study, we are interested in finding out the earliest stage when English-learning infants develop the knowledge of the verb-action connection. We look at 14- and 18-months of age; infants at these two developmental stages are believed to be able to recognize that a novel word is a verb based on its place in sentences (e.g. is Verb-ing), but do not yet use verbs in their own speech.

To explore children's knowledge, we first presented them with two sets of stimuli – in one set, a penguin-spinning scene (Figure 1a) was accompanied by the description 'look, it's doking', and in another, the penguin-cartwheeling scene (Figure 1b) was accompanied by the description 'look, it's praching'. As adults, we are able to categorize the invented words doke and prach as verbs, and use our knowledge of the verb-action connection to infer that doke and prach are likely to label the spinning and cartwheeling actions respectively.

To find out if 14- and 18-month-olds make the same inference, we presented these two sets of stimuli repeatedly until the children lost interest, as indicated by their decreased looking time. When they lost sufficient interest, we switched the combinations between the scene and the description – for example, we now paired the spinning scene with 'it's praching' (as opposed to 'it's doking). Children at both ages noticed the change and hence recovered their interest and increased their looking times. (Figures 2a & 2b). This suggests that children matched each verb with one of the events.

We then wanted to find out whether children had a specific expectation about verbs referring to events, or if they would notice any change in the video-audio pairing. To find out, we presented infants with a penguin-spinning scene paired with 'it's a doke' and a penguin-cartwheeling scene paired with 'it's praching'. There were two types of switches: in one, there was a change in meaning – for example, praching that was originally used to label the cartwheeling action was used to label the spinning action; in another, no meaning change was involved – for example, doke was still used to label the penguin. We found that 14-month-olds increased their attention after both types of switches, regardless of meaning change, whereas 18-month-olds only showed increased looking to the type of switch where there was a change in meaning (Figures 3a & 3b). This suggests that 14-month-olds do not approach this task using specific expectations about verb meanings, but that 18-month-olds have an understanding of the verb-action connection.

Figure 1a

Figure 1b

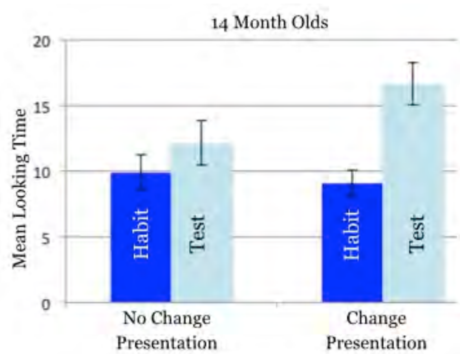


Figure 2a

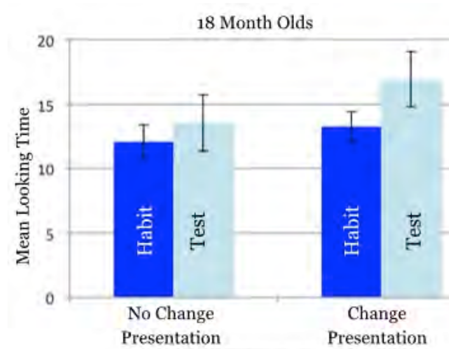


Figure 2b

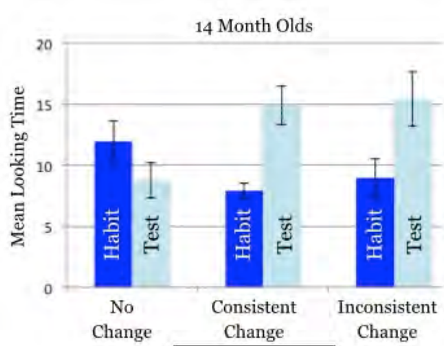


Figure 3a

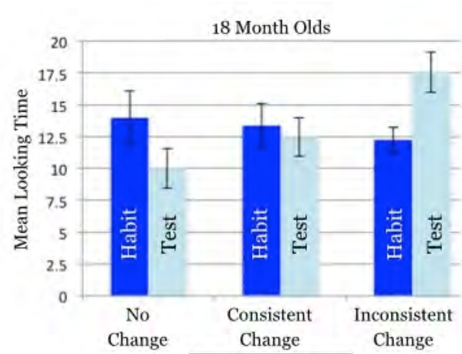


Figure 3b

Want to help our labs even more?

Tell other parents about us! If you are a member of a parent's group or listserv, we would greatly appreciate you telling other parents about your experiences taking part in studies at UMD. Simply letting other parents know we exist gives them the opportunity to choose whether or not to participate.

Our research couldn't happen without interested parents like you. Thank you so much for helping us learn more about how children develop and learn!

Talking About Thinking

Humans spend a lot of time trying to understand or predict what people will do based on what's going on in their minds. Adults are very good at this: we are able to use very subtle or indirect clues to infer what another person is thinking or feeling. Children, on the other hand, have difficulty keeping track of other people's beliefs. In particular, children under 4½-5 years old seem to have trouble understanding that people can believe things that aren't true—that is, that people can have "false beliefs."

We examined how 3-4 year-old children interpret sentences about false beliefs. We told children stories about hide-and-seek. For example, in one story, Boots hides, and Swiper and Dora go looking for him. Swiper correctly guesses that Boots is behind the door, and Dora incorrectly guesses that he is under the bed. Then we asked children to evaluate sentences about what Swiper and Dora believe. We found that children correctly reject sentences like, "Dora thinks that Boots is behind the door." They know that Dora doesn't think Boots is behind the door, even though it's true in reality. However, they also incorrectly reject sentences like, "Dora thinks that Boots is under the bed," on the grounds that Boots isn't really there.

What can explain the pattern of children's correct and incorrect responses? The key to this puzzle is looking at how adults use verbs like 'think' in conversation. Although it might seem like a sentence with 'think' would have to be about someone's belief, that's not always the case. Most of the time, when we say 'think', we're not talking about beliefs at all. Consider a sentence like, "I think it's time for you to go to bed!" The mom who says that sentence to her child is not trying to explain her beliefs about bedtime. She's really saying, "It's time for you to go to bed, so you'd better march!" A sentence like, "Dad thinks it's time for you to go to bed," would work in the same way. If Dad thinks it's time, it's time! When we look at transcripts of parents speaking to 2-3 year-old children, we find that there are almost no cases where they're actually talking about beliefs. Parents don't tend to talk to their children much about mental states until the children are 4-5 years old, or even older.

That doesn't mean that children don't understand beliefs until they're 5 years old. Some studies suggest that even 1-year-olds have some understanding of beliefs. What children struggle with is understanding when we're talking about beliefs, and when we're not. That is, they don't always know when a person's beliefs are important in a given situation. So when we ask them to evaluate a sentence like, "Dora thinks that Boots is under the bed," they don't know whether we really care about what Dora believes, or whether we're just trying to say something about where Boots is.

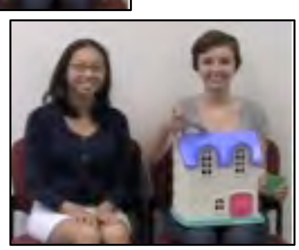
How do children " pronouns?

Recent research in the Project on Children's Language Learning Lab has further uncovered the ways in which children interpret pronouns, showing that children are much like adults as young as 30 months old. Previous findings from our lab showed that by this age, children recognize restrictions on which person a pronoun in a sentence could refer to. For example, in a sentence like "she's patting Katie," children understand that the pronoun "she" can't refer to Katie, and must instead refer to another (unmentioned) girl.

Our current research questions whether children arrive at this interpretation the same way that adults do, or if they begin with a simpler strategy before developing a full adult-like understanding of pronouns. For adults, we know that pronoun interpretation is tied to the complex structure of the sentence, rather than the linear order in which words appear. To illustrate this, consider the two sentences below. The pronoun she comes before the name Katie in both sentences, but the possible interpretations are different. In sentence (1), the pronoun can't refer to Katie, as with the simpler sentence "she's patting Katie." Sentence (2), however, is ambiguous between two meanings: "she" can be interpreted as referring to either Katie or another girl.

(1) She's painting the house that's in Katie's lap
(2) The house that she's painting is in Katie's lap

Results from our original study with sentences like "she's patting Katie" are consistent with children interpreting pronouns based on sentence structure like adults, but they are also equally consistent with children using a word order strategy. This study was designed to determine which of these two strategies young children use when interpreting a pronoun.



To test this, we showed 28-32 month-old children two videos simultaneously. In both videos, two characters – Anna and Katie – interacted with an object held by one of the girls. For example, as in Figure 1 below, Anna painted a house on Katie's lap in one image, and Katie painted the house in her own lap in the other. Children then heard one of the two sentences above. If children use linear order of words to interpret the sentence, then they should behave similarly when hearing either sentence, looking more to the video where Anna was painting the house. However, we found instead that children who heard sentence (1) look significantly more at the video with Anna painting; children who heard sentence (2) were more likely to look between both videos equally. This result mirrors adults' interpretations of such sentences, and suggests that children's pronoun interpretations are not driven by linear order, even as young as 30 months- like adults, children rely on the complex structure of the sentence to interpret pronouns.

We're always so glad to meet the families who participate in our research.

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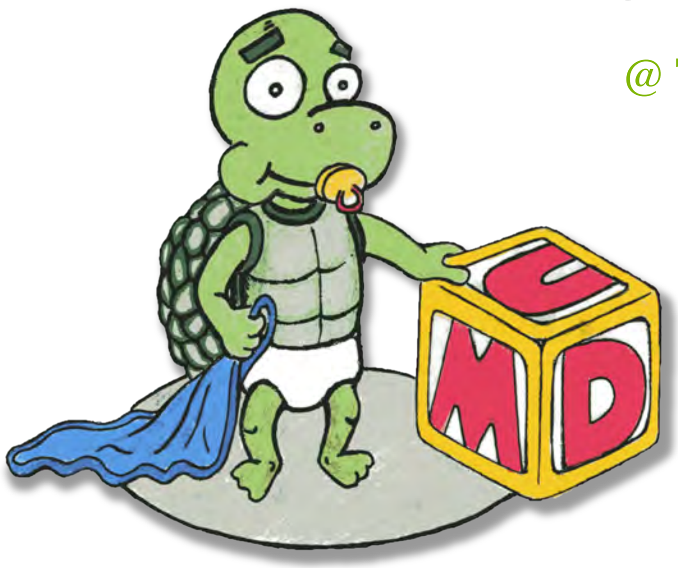

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