# Toddler & Preschooler News, 2002

Sometime over the last six months, your child participated in one of our studies. We are writing first of all to THANK YOU for your participation. We couldn't do our research without your help and we really appreciate your interest in our work. We also wanted to let you know what we learned from the studies we conducted. In this newsletter, you will find out the results of several different studies completed recently in our lab – your child participated in one or more of these studies.

If you have any questions about these studies or the lab in general, please feel free to call us at (617) 384-7930 or (617) 384-7777. We hope to have you come visit for more studies soon! Thank you!

## DAX STUDY
## Justin Halberda, Graduate Student

The Dax studies investigated possible strategies that babies might use to learn new words. When a child is faced with something that she has never seen, and at the same time a word that s/he has never heard, how does she learn to attach the word to the object? One technique might be to use a process-of-elimination strategy. If the child is familiar with the names of all of the other objects in her surroundings, then she can rule them out as possibilities.

The Dax studies looked into this potential strategy by letting children watch two computer screens that each showed a different picture and asking them to "Look at the [object]". Sometimes, both of the pictures were objects that children are generally familiar with and might know the names of, things like cars, balls, cups, balloons, dogs, etc. While the pictures were up on the screen, the child was asked to look at one of them. Sometimes, one of the pictures was a made-up object, something we invented in the lab so that we knew children wouldn't have heard of it before.

When asked to "Look at the dax," adults might reason through the problem in the following way: "I don't know what a DAX is, but I know that that's a car, so it's probably not a dax. So that funny-looking thing on the right must be a dax." So far in the Dax experiments, we have found that two-year-olds solve this problem in just this way, and so do 17-month-olds. By recording where children look, we are able to see them reasoning through the problem and that they end up choosing the funny-looking (novel) object as the "dax". In fact, we've also shown that the two-year-olds are able to learn the names of the novel objects from just one trial lasting 2.5 seconds! For babies from 14- to 16-months, it seems they are trying to use this same word-learning strategy, but run out of time. After being asked to "Look at the dax," these babies increased their looking to the familiar object [car]. Perhaps these infants are performing the first step in the strategy, "I don't know what DAX is, but I know that that's a car." We are currently running a new study, giving 14- to 16-month olds more time to go through all of the steps in the strategy.

## EVENT COUNTING STUDY
## Laura Wagner, PhD

In the Event Counting studies, we showed children short animated movies showing, for example, a girl painting the door of a house or a dog pushing a ball into a can. We described the events in different ways, sometimes focusing on the process ("The girl painted") and sometimes focusing instead on the result ("The girl painted the door"). We asked your child to count what happened in the movie and we were hoping to find that the way we described the event would influence what s/he chose to count. Each movie was specially constructed so that it always took distinct multiple process steps to achieve each result.

For the young children in this study, we used real English words to describe the movies. These children often had a difficult time counting (children at this age are really just at the beginning stages of counting – see the results from the "What's On This Card" study), but they had no problems pointing at the screen at different times. When we coded children's pointing, we found that even these young children seem to understand the differences between the process and result descriptions. When we described the process of an event such as "the dog pushed the ball," children pointed at the act of pushing. When we described the result of an event such as "the dog pushed the ball into the can", children waited until the ball went into the can and pointed to the result of the event. We used different kinds of events (some depicted acts of creation, others of motion) and different kinds of sentence structures, but these young children were able to succeed with everything! These results show us how quickly children's language skills become quite sophisticated. Before they are even 3 years old, children can use relatively subtle distinctions in linguistic forms to extract differences in meaning.

The version of this study that we ran with the older children was aimed at finding out what kinds of information in the sentences children were using to figure out whether we were talking about the event's process or result. The basic set-up was the same as for the young children, except we replaced all the verbs with nonsense terms. That is, we asked children to count "How many times the girl 'glipped' the door." We were interested in whether older children could use the structure of the sentence itself to help them determine meaning. Our results in this study suggest that the structures alone are not strong enough to guide children's interpretations. Regardless of which kind of sentence structure the nonsense words appeared in, children overwhelmingly chose to count the event's process steps and not the event's results. This result is consistent with previous findings from this lab that children have a general bias to focus on the process instead of the result in this task, but this is the strongest evidence for this bias we have gotten so far.

The next step in this line of research is to ask what children know about how the verbs and nouns work together in a sentence to determine if the focus is on the process or the result. For example, "The girl ate ice-cream" and "The girl ate an ice-cream cone" differ only in terms of the noun in direct oject position, but the first focuses on the process and the latter on the result of the event. Because children find this task engaging, we hope to continue using it to investigate their early knowledge of linguistic forms.

## IMPOSSIBLE-IMPROBABLE STUDY
## Andrew Shtulman, graduate student

Our study aims to investigate when, and by what means, children come to differentiate improbable and impossible events. Given that human beings, unlike other animals, can learn about events and entities they have not personally experienced, the ability to distinguish possible outcomes and impossible outcomes becomes crucial when evaluating the truth of questionable testimony. For example, few adults, on hearing that their neighbor was struck by lightning, would deny the truth of this statement outright, yet most adults, on hearing that their neighbor had traveled back in time, would. Whereas the former event is improbable, yet possible, the latter event violates a law of nature (i.e., that time flows in one, and only one, direction) and is therefore dismissed outright. Do children's intuitions regarding possibility accord with adults'?

To address this question, we created an illustrated children's story that contains eight probable events (e.g., washing a car), eight improbable events (e.g., finding an alligator under the bed), and eight impossible events (e.g., walking through a wall). Adult control subjects claimed that 100% of the probable events, 98% of the improbable events, and 10% of the impossible events were possible. Like adults, children, aged 4 to 6, claimed that 95% of the probable events and 6% of the impossible events were possible. However, unlike adults, children claimed only 21% of the improbable events were possible – a highly significant developmental difference. Analyses of individual response patterns revealed that older children judged a larger percentage of the improbable events as possible. Nevertheless, no child exhibited a response pattern statistically similar to the response pattern exhibited unanimously by the adults in that no child judged six or more improbable events as possible.

Although the possibility judgments suggest that children did not differentiate the improbable events from the impossible events, children's justifications suggest otherwise. Children gave significantly more pragmatic and / or affective justifications for improbable events than impossible events (e.g., finding an alligator under the bed is impossible because "alligators can't open doors" or because "the alligator might bite you") and significantly more magic-based justifications for impossible events than improbable events (e.g., walking on water is impossible because "that's magic" or because "that only happens in stories"). In comparison to the children, adults gave very few pragmatic, affective, or magic-based justifications. Rather, 68% of adults' justifications referred explicitly to a violation of nature (e.g., opening a window with one's mind is impossible because "objects move only when forces are applied to them"). Although some children did make reference to a violation of nature – albeit, in much simpler terms than the adults – such justifications comprised only 9% of the total number of children's justifications.

One preliminary interpretation of these results is that adults and children use different strategies to evaluate possibility. Adults' response patterns and justifications suggest that adults interpret questions of possibility as explicit exercises in logic – i.e., adults *deduce* possibility from their knowledge of relevant laws of nature. Children, on the other hand, appear to assess possibility on the basis of personal experience or local knowledge obtained prior to the experimental session. For example, whereas adults seemed to use their knowledge of physical objects to judge the possibility of a man walking through a wall (e.g., that two objects cannot occupy the same space at the same time), children seemed to use their knowledge of walls (hence, justifications like "walls are big" and "I've never seen anyone walk through a wall"). Although this strategy allowed children to deny the possibility of impossible events, it also lead them to deny the possibility of improbable events, since they had not experienced either type of event. Given that children's justifications reflect at least an implicit distinction between possible and impossible events, it remains to be seen when children can access this distinction explicitly. Thank you and your child again for your participation!

## OBJECT INDIVIDUATION STUDY
## Peggy Lee, PhD

The Object Individuation study investigates why we see some things as kinds of objects and other things as kinds of substances. Any time we see something (e.g., a wooden whisk), it is possible to think of that particular thing as a kind of object (whisk) or as a kind of substance (wood). Our classification is heavily influenced by the nature of that something we see. For example, as adults, we are more likely to think of a wooden whisk as a kind of object (whisk) and a rectangular-shaped wooden board as simply a kind of substance (wood). This is perhaps because when we think of something as an object, we think of its shape or structure as being important, whereas the shape of a substance is typically unimportant. A whisk is a whisk because of its particular shape, whereas a piece of wood can be of any shape and still be wood. One question is whether children are like adults when classifying novel things as objects or substances. Compared to adults, children are less experienced with the nature of things. Perhaps the difference in amount of experience would lead to differences in how children and adults classify novel things. Of interest too is whether children distinguish between objects and substances, and how early they start to make this distinction.

For this study, we tested two- through four-year-olds and compared their behavior with adults. As our test items, we chose a variety of things that are novel to most children. The things vary in shape complexity (e.g., a whisk versus a cylinder) and solidity (e.g., wood versus hair gel). For each trial, we first show a test item (e.g., wooden whisk) and then ask the children to pick another example like the first. The choices were either an object choice (something of the same shape, like a metal whisk) or a substance choice (something of the same material, like a chunk of wood). For an example, please refer to the pictures below.

Our findings thus far suggest that when children are presented with complex solids (like a whisk) they are more likely to see these entities as objects, rather than substances. For instance, in the whisk example, most children choose the metal whisk instead of the pieces of wood as being more similar to the wooden whisk. The reverse seems to be true for non-solid substances, like lotion or powder. When children are presented with a spiral made out of lotion, for instance, they more often pick a blob of lotion as being the same, rather than a spiral made out of hair gel. This suggests that children already know something about the nature of non-solids, and see them as kinds of substances rather than as kinds of objects. Finally, simple solids (like cylinder-shaped cork) are seen by roughly half of the children as objects (cylinder) and by the other half as substances (cork).

Overall, the results show that children behave very much like adults. We are currently testing older one-year-olds and younger two-year-olds to see if the pattern holds for an even younger population. Future research will also examine whether we can influence how children think of novel things by providing telling them about its functions. For example, if told that a sponge cube is used to absorb water, would the child more likely to think of the thing as a substance? In contrast, if told that the sponge cube is used as a toy block, would the child more likely think of the thing as an object? In other related work, we also explore whether language learning influences the way one sees a novel thing as an object or as a substance.

## RED WALL STUDY
## Anna Shusterman, graduate student

We are delighted to share the results of our study on spatial cognition in four-year-olds! The goal of this study was to explore the possibility that learning spatial language terms changes how children navigate through space. In our experiment, we tried to teach children the words 'left' and 'right' and then tested them in a rectangular navigation room with one red wall. In the navigation room, children watched a toy or a sticker being hidden in a corner. They were then blindfolded and turned around so that they lost their intuitive sense of orientation. When they stopped and the blindfold was removed, they were allowed to search for the toy or sticker. Previous studies with 'reorientation room' tasks like this one have shown that young children will use the geometry of the room to guide their search, but not visual landmarks like a red wall. One possibility is that children must have the ability to think a complex phrase like "the toy is to the left of the red wall" in order to use landmarks for searching behavior. If this is the case, then teaching children phrases like this should help them succeed in navigation tasks.

We taught children two kinds of meanings of left and right – body part meanings (for example, your right arm) and object relationship meanings (for example, the toy on your left). We discovered that, in general, children learned body part meanings much more readily than object relationship meanings. (And a good number of children didn't learn either meaning.) However, the children who learned both kinds of meanings performed much more accurately in the navigation room. This suggests that having a more abstract idea of 'left' and 'right' and an ability to use these terms in complex phrases helps children make sense of their spatial environment. This finding is exciting because it is one of the few studies demonstrating that teaching children particular pieces of language can affect their behavior in a non-linguistic task. Further studies are exploring the mechanisms underlying this developmental change and investigating in more detail how children learn spatial language.

Some children came in only for language games to help us refine our teaching methods. Other children came in only for the navigation game to help us establish a baseline measure of how children this age behave in the navigation task without language training. Thank you to all who came in – we could not have done it without you!

## REFERENCE BRIDGING STUDY
## Laura Wagner, PhD

The Reference Bridging study was looking at the early origins of children's story-telling abilities. One reason children's early stories are sometimes hard to follow is that children will often use pronouns without proper support. That is, children might say something like "She was in the store" without having previously identified who "she" was. In this study, we were interested in finding out when children understand that pronouns should be linked to previously mentioned referents, and what kinds of conditions might make children overlook this fact.

We showed children pairs of pictures on a computer screen. We described one of the pictures and then asked a question using a pronoun. For example, in one trial, we said "Here is a boy with brown hair. Are his mittens polka-dotted?" In some of the picture pairs, one of the items had a highly noticeable element (such as polka-dotted mittens on boys).

We suspected that children would be distracted by these elements and would allow pronouns to refer to these distinctive items, even when our descriptions didn't mention them. Our results showed that 4 year olds were NOT distracted by the noticeable elements and always used our descriptions to guide their interpretation of the pronouns. The 3-year olds, however, did make mistakes on these cases. That is, when there was no distracting item present, 3-year olds do understand pronouns like adults (and 4 year olds) do, but when there is a particularly noticeable item present, 3 year olds allow pronouns to refer to it, even without linguistic support.
We are continuing this project by trying to understand what changes between 3 and 4 year olds. In particular we are interested in whether the older children are just less distractible than the younger children, or whether they have better learned the linguistic rule about pronouns.

## WHAT'S ON THIS CARD?
## Mathieu LeCorre, graduate student

Previous work in our lab has shown that it takes a long time before children understand how their count list represents number. That is, children do memorize a count list around age 2 but they do not understand how to use it to determine the number of objects in a set. In the What's on this card study, we were interested in whether children learn an approximate meaning for their number words before they learn how to count. That is, do they know that "eight" refers to a bigger number than "three" even if they don't know the exact meanings of either word? We presented children with cards depicting up to 10 objects and asked them to guess how many objects were on the cards. We found that number word meanings develop in an interesting way.

First, children restrict their use of “one” to sets of 1, but use “two” to describe all numbers greater than 1. A few months later, they use “two” to describe sets of 2 and “three” to describe sets of 3, but use “four”, and “five” to describe all numbers larger than 3. Then, around age 4, they learn how to use the count list to determine the number of objects in a set, and thus learn the exact meaning of all the number words in their count list. In sum, until they learn the numerical meaning of counting, children can only guess how many objects are in a set if the set contains less than 4 objects.

It’s not until many months *after* children have learned this that they are able to guess how many objects are in sets that contain more than 4 objects. Therefore, our results suggest that, oddly enough, for number words beyond “three” (e.g. “four” and “five”), children learn the exact meaning – i.e. the meaning given by the count list – before they learn the approximate meaning – i.e. the meaning that comes from the approximate number sense. In other words, the ability to use counting to represent number emerges *before* children’s number words are fully integrated with their innate approximate number sense. Thus, how children actually create the count-based representation of number remains a puzzle.