MIT Language Acquisition Lab

2021 Newsletter

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Dear parents, educators and other friends of the Language Acquisition Lab,

This newsletter showcases some of our recent work, as well as studies that are ongoing. Our work focuses on some of the most complex aspects of language – meaning, inference, and implication, to name a few. Our studies are designed to boil down these complex phenomena into more easily testable chunks, such as a particular word or phrase or grammatical construction. Through this method we work to tease apart how children, and therefore humans in general, acquire these aspects during their early years, during the pivotal age range where they can speak and be understood, but do not yet use language like adults do. This can teach us a great deal about children, about language, and about humanity. If you have a child still learning their native tongue, we hope to see you both soon to play one of these games! As we head into our Spring semester here at MIT, we wish you a safe and comforting 2021. Thank you for supporting our work in the study of language acquisition! We could not do it without your help.

With warm regards from the MIT Language Acquisition Lab Team

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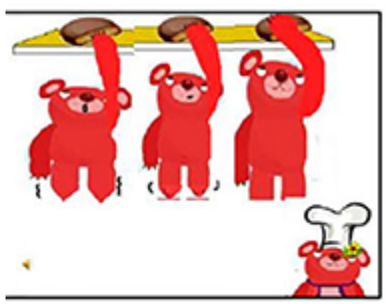
Even Project

What we investigated: *Even* is a funny word, because unlike *dog* or *blue*, which mean something you can point at, *even* as in "Even Jessie was able to reach a cookie" does not have a meaning you can point to, but rather tells us something about the context, namely that Jessie was unlikely to reach a cookie for some reason (i.e. maybe because she is short).

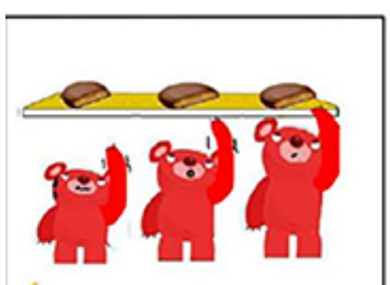
Children ages 3-6 are usually adept at words like *dog* and *blue*, but we know less about whether they can detect the more complicated inferences associated with words like *even*. Thus the goal of our study is to see whether they know what *even* means and if not, how they respond to *even* in context -- do they ignore it, or do they try to interpret it?

The way we do this is by exploiting another property of *even*, namely the fact that its inference changes in the presence of negation.

1. Even Jessie was able to reach a cookie.
    a. Inference: Jessie was the *least* likely to reach a cookie.



2. Even Jessie wasn't able to reach a cookie.
    a. Inference: Jessie was the *most* likely to reach a cookie.



Our experimental design includes sentences with *even* in both positive and negative varieties (as in (1) and (2)), and asks children to choose from amongst the group of characters, which one they think Jessie is, given only those descriptions.

Children with an adult-like command of *even* should choose the shortest character in the group when presented with (1), but the tallest character when presented with (2).

What we found: Despite *even*'s unusual characteristics, we found that children had an adult-like command of it by age 4. In addition, even when children occasionally didn't understand sentences containing *even* in an adult-like manner, they weren't simply ignoring it -- their responses to these sentences suggested that they have access to a different meaning for *even,* one that is the opposite of the adult-like meaning. That is, when they heard a sentence like (3), they sometimes interpreted it to mean that Jessie was the most-likely to reach the cookie instead of the least-likely one.

3. Even Jessie was able to reach a cookie.
    a. Opposite child inference: Jessie was the *most*-likely to reach the cookie.

If we compare this interpretation to the adult-like interpretation in (1a), it's a little strange! We normally use *even* in a sentence to indicate that the event it describes went against our expectations. But on the interpretation in (3a), *even* would indicate that Jessie's having reached a cookie was actually expected, because she was the *most*-likely to do so.

This indicates that children are aware, very early on, that *even* comes with a *most*-likely and *least*-likely inference. What they don't necessarily know is which inference belongs to which context (i.e. positive vs. negative sentences).

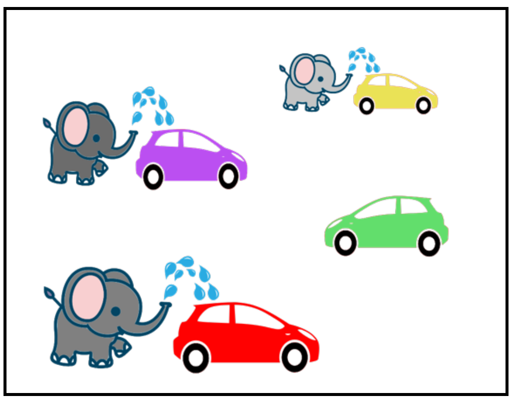
We hypothesize that they eventually learn the right pairing of inference and context as they become more adept at recognizing the goals of conversationalists. A preference for talking about things that are surprising helps them unlearn the "opposite" inferences.

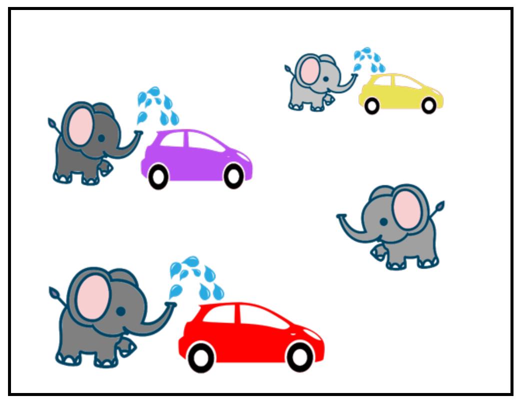
This study was published in the journal *Frontiers in Communication*. Here is a link to the paper: https://www.frontiersin.org/articles/10.3389/fcomm.2020.593634/full

Quantifier Spreading Project

What we investigated: Quantifier Spreading is the name of a phenomenon where children (as was demonstrated in previous studies) associate quantifier words like "every" with more parts of the context than an adult would. When shown a picture of three elephants, each washing a car, and an extra car not being washed (by an elephant), children often reject the sentence in (1), saying that it is silly, and point to the extra car to justify their answer. This erroneous response arises when children start to reject (1) correctly when there is an extra elephant in the picture, or in other words, as soon as they know the meaning of *every*.

(1) Every elephant is washing a car.





To our knowledge, the interaction of this phenomenon with negation had not been studied. We investigated whether children would accept the sentence in (2) when there is an extra car or an extra elephant in the picture.

(2) Not every elephant is washing a car.

The presence of 'not' in (2) negates the rest of the sentence, which is identical to the sentence in (1). Intuitively, if children respond negatively to (1), it makes sense if they respond positively to (2).

But not every linguistic theory makes this prediction. Recently, some researchers proposed that children's negative responses to (1) when there is an extra car in the picture are because of the fact that they put *more* restrictions on the truth condition of

(1): ‘every elephant is washing a car’ is true if (i) for every elephant in the picture, it is washing a car, *and* (ii) for every car in the picture, it is washed by an elephant.
Under this theory, when there is an extra car in the picture, children reject (1) because condition (ii) is not met.

This theory does not predict positive responses to (2) when there is an extra car in the picture, unless it also allows for them to put *less* restrictions on the truth condition of (2):
‘not every elephant is washing a car’ is true if
(iii) at least one elephant in the picture is not washing a car, *or*
(iv) at least one car in the picture is not washed by an elephant.
This is because when there is an extra car in the picture, condition (iii) is not met; therefore, unless they can accept (2) when condition (iv) alone is met, children should reject (2) simply because condition (iii) is not met.

What we found: Not surprisingly, we found that children who rejected (1) when there is an extra car in the picture, also accepted (2) when there is an extra car in the picture, and that they accepted (2) correctly when there is an extra elephant in the picture. In other words, children who “spread quantifiers” still do so when the sentence is negated.

It would be rather strange to assume that children put *more* restrictions on the truth condition of (1) but put *less* restrictions on the truth condition of (2). Thus, we suggest that what leads to children’s erroneous responses is an inference they draw from the extra car in the picture: putting the extra car aside, there is a one-to-one relationship between elephants and cars in the picture; this, we propose, leads children to assume the existence of an unseen elephant which is not washing the extra car. With this inference, we expect children to reject (1) but accept (2) without making any additional assumptions about the truth condition of (1) and (2). This hypothesis is consistent with the explanations that our participants gave us for their answers; in some cases, when kids rejected (2) in an extra-car scenario, they explained that “he’s not washing this one” or “this one left without washing it”.

Conjunction Project

What we are investigating: Words are usually "picky" about the other words that they can combine with: the definite article *the*, for example, can combine with nouns like *dog* but not verbs like *sing*, and it's the other way around for the auxiliary *should*. However, the English coordinator *and* is not picky in the sense that it can coordinate nouns (*dogs and cats*), verbs (*sing and dance*), and even full sentences (*Victoria smiled and Anna cried*). Our research goal is to find out whether children between 3 and 6 years of age have an equally good command of understanding when *and* coordinates different linguistic elements.

We investigate this question by exploiting sentences in which different occurrences of *and* lead to different meanings. In (1), *and* coordinates two sentences, and this is most naturally used in a context in which a chili pepper and a banana are in two separate boxes. But in (2), *and* coordinates two noun phrases, and can only describe a scenario where a single box contains both items.

(1) [A box contains a chili pepper] and [a box contains a banana].
(2) A box contains [a chili pepper] and [a banana].

In our experiment, we have created a scenario where our friend Teddy is going to a picnic, and has to choose which table to sit at, with the help of our child participants. The two tables, Panda's table and Duckie's table, each have two boxes in which the mentioned objects -- in this case, a banana and a chili pepper -- are distributed differently. On Panda's table, one box contains a banana and the other box contains a chili pepper, a scenario which adult speakers of English can truthfully describe using (1). On Duckie's table, a single box contains a banana and a chili pepper, a scenario that can only be described by (2).

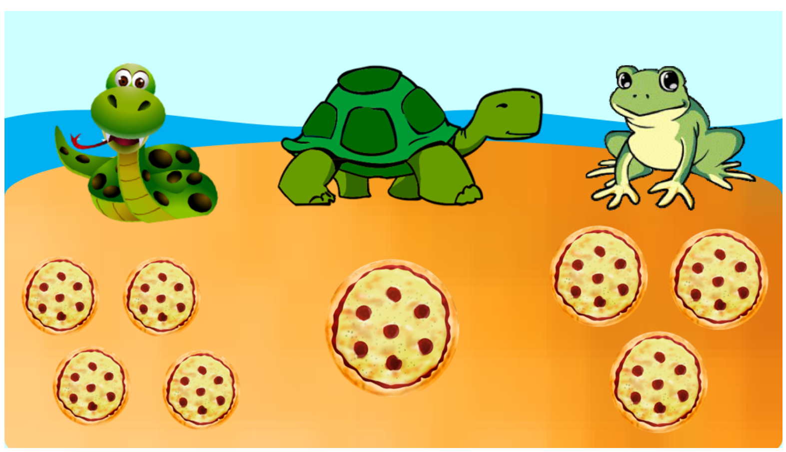
Children with an adult-like command of *and* should choose Panda's table when the instruction for Teddy takes the form of (1), and Duckie's table when the instruction is like (2). We are interested in seeing whether there is an asymmetry between these two types of conjunctions in 4-6 year-old children's command of *and*.

This work is ongoing in the Lab via Zoom. Children ages 4-6 are welcome to participate!

Comparative Quantifiers Project

What we investigated: Numerals are words that describe quantities. "Vague" quantities of objects (like "lots" or "a little bit") seem simple and intuitive, and animals such as ravens are able to compare them. On the other hand, it seems that only humans have a fully general ability to measure and reason about precise quantities, which are referred to by the set of natural numbers. When children first learn to count, they do so one number at a time, for the first several numbers, until eventually they learn the principles that tell them that the next number is always exactly one higher than the number before it. We wanted to understand how children view numerals and quantities during this in-between stage, when they understand quantities and what numerals are, but don't fully understand the system of numerical ordering yet. To do this, we ran an experiment that evaluated children's ability to count up to various numbers, and then evaluated their ability to use comparative phrases.

First, we had children demonstrate their counting skills by putting stars in a basket. Then, we told them stories about animals, and that a puppet would try to figure out what happened in the story. They would then tell the puppet whether he was right or being silly, and why. Our stories would end in scenes like this one:



In the story with this scene, our puppet would say four sentences like these:

a. The snake has **more** pizzas **than** the frog.
b. The snake has **more than three** pizzas.
c. The snake has **one more pizza than** the frog./The frog has **two more pizzas than** the tortoise.

What we found: We arranged these sentences so that half of the time they were true, and half of the time they were false (or "silly"), with respect to the scene. We were not surprised to see that children got these a and b sentences right almost all of the time, which seems to indicate that they are comfortable comparing quantities of objects, and even comparing them directly to familiar numerals as their standard of comparison. But for the c sentences, they would almost always say that these sentences were silly, even when an adult would say they were true. When we asked them why they thought the sentences were silly, they would say things like, "The snake doesn't have one, he has four!" or "The tortoise is the one who has one!" It seems like many children interpreted "The snake has one more pizza than the frog" as "The snake has one pizza"!

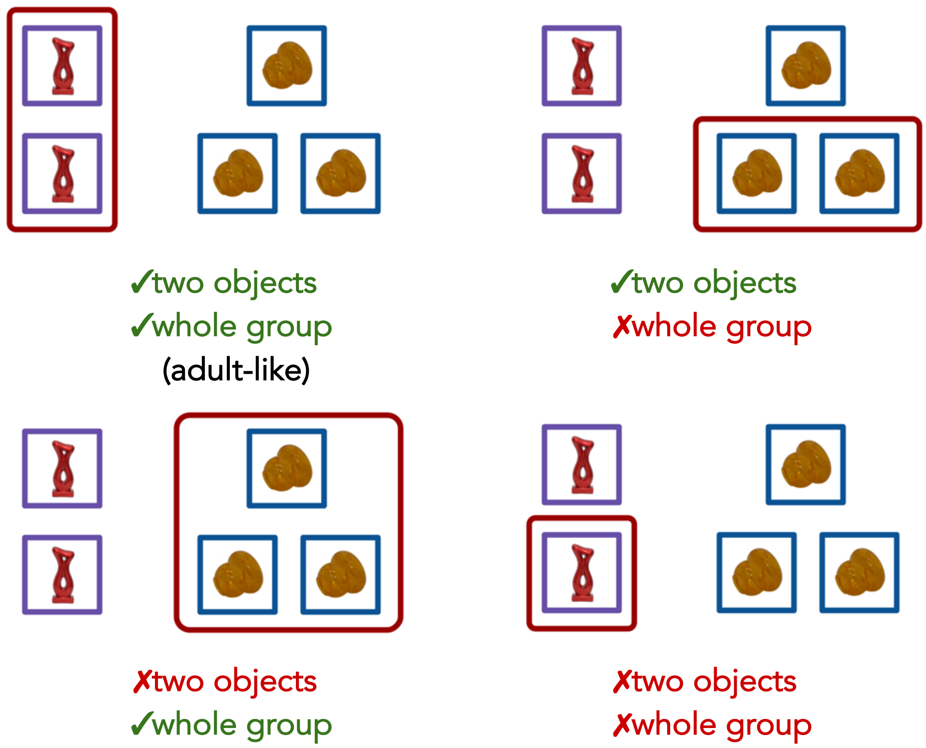
Our theory of why this happens is rooted in the theory of what the numerical system is made of - what you need to know to be able to use numbers like an adult. Kids seem to know the Cardinality Principle - the principle that the last number word used in an orderly counting of a set corresponds to the precise number ("cardinality") of the set, but they seem to lack what is called the Induction Axiom, which is the principle that tells them exactly how big the difference is between each adjacent number. When they try to compute this, they fail and fall back to a different interpretation of the sentence entirely, because they only know how to interpret a numeral as a standard, not as the quantity of the difference between two other numbers. We are working on a follow-up study to test our hypothesis, which we hope will show us whether they can understand "a few more pizzas" better than "two more pizzas". This will help us distinguish between different possible explanations for the results that we got in this study.

Both/Either Project

What we investigated: In English, we can use quantities to express how groups of items relate to each other. *All the stars are red*, for example, means that every object that is a part of the group *stars* is also a part of the group *things that are red*. Some of these relationships are more complex than others: for example, *more than two stars are red* means that the number of items that are a part of both the group *stars* and *things that are red* must be three or greater. Finally, some of these relationships, despite being complex, are expressed by simple words. This is the case for the words *both* and *either*, which appear simple on the surface, but have more complex meanings. Namely, the word *both* requires (i) a group of exactly two objects, and (ii) all of the items from that group. (*Either* is similar, but only strictly requires a group of exactly two objects). In this study, we investigate 2 to 4 year old children's understanding of the words *all*, *any*, and *two*, which express the individual components of *both* and *either*, and the words *both* and *either* themselves, to see how the individual components develop compared to the words *both* and *either* overall.

To do this, we created a scenario where the quantity word was the only information that could be used to form a response. In the experiment, our friend Wilbur the pig showed children two different kinds of unrecognizable items, divided into two groups of two and three items. The researcher mentioned the names of the items using nonsense words, but didn't specify which word went with which image. Then they asked, "Can you give me *two/all/both/either/any* of the [nonsense word]?". Since the word-image pair was unspecified, the quantity word was the only part of the request that the child could use to form an answer. Each kind of response gave us different information about what number and group size children thought each word required.

Look! Here are some blickets and some zavs! Can you give me both of the zavs?



What we found: The results of the *both* experiment revealed that the understanding of the individual parts of *both* did not necessarily mean that the adult version of *both* was understood, as well. The majority of the children associated the word *both* with giving two objects, but were much more inconsistent about the group size they selected. In fact, the proportion of 2-out-of-3 and 2-out-of-2 responses to *both* were similar to *two*, suggesting that children might be treating *both* just like *two*.

For the word *either*, the results confirmed that children associated *either* with giving at least (but not always exactly) one item, but were again almost equally divided between choosing from the 2-set and 3-set, indicating that they did not yet understand the group size requirement of this expression.

Presupposition Projection Project

What we are investigating: Imagine someone tells you an if-then sentence like *If John plays his trumpet, then the dog will bark a lot.* If you later find out that John played his trumpet but the dog didn't bark at all, you may briefly think that person was misinformed: they must be wrong about the consequence of John's playing of his trumpet. However, you would be much more confused if you found out later that in fact, John doesn't have a trumpet at all. This is because when a listener hears "if John plays his trumpet...", the sentence prompts them to assume that John does *have* a trumpet. Interestingly, the precise location of the possessive phrase *his trumpet* in a "**conditional** sentence", like the one above, can significantly affect what assumptions can be drawn from that sentence. In this study, we investigate whether children draw the same sorts of assumptions from these types of conditional statements as adults.

To do this, we created two versions of a "dress-up game" where children must decide if our friend Bailey the bear was dressed up according to a set of instructions. In one version, a requirement that was mentioned in an *if*-clause of the condition was left unfulfilled; so, the instruction might say "If the shirt you put on is blue…", but Bailey has no shirt on. In the other version, a requirement mentioned in the *then*-clause was left unfulfilled, as in "...then, the shirt you put on has to be blue." If the child think that Bailey didn't follow the instructions, they are invited to help Bailey fix her outfit by adding or removing clothes to fit the instructions.

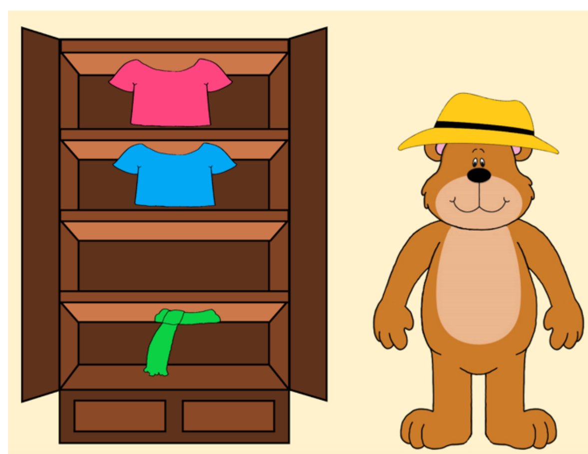
Instructions:

You have to put on a hat.

i. If *the shirt you put on* is blue, then you have to put on a scarf.

[or]

ii. If you do put on a scarf, then *the shirt you put on* has to be blue.



For adult speakers of English, sentence (i) is harder to process in this situation, because the unfulfilled assumption coming from "the shirt you put on" must be dealt with before one can judge the truthfulness of the whole sentence. For children, we collect their responses of whether they think Bailey followed instructions, and what changes may be required to do so, to inform us if children understand sentences like (i) and (ii) in a similar manner.

This study is ongoing, and children ages 4-6 are welcome to participate!

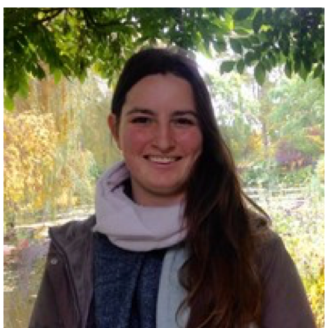
Lab Members

Lab Directors:

Dr. Athulya Aravind, Ph.D.

Dr. Martin Hackl, Ph.D.

Lab Managers:



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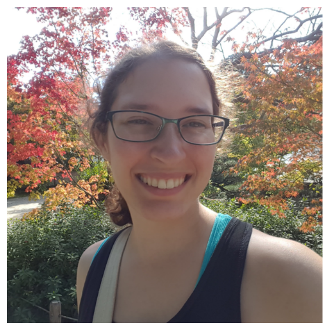

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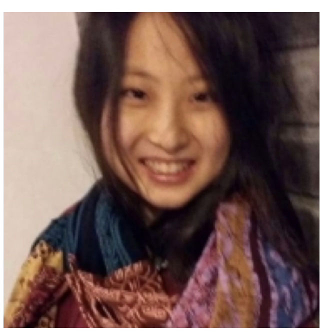
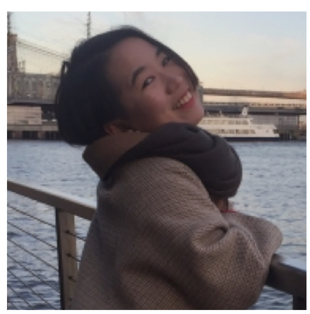


Fulang Chen



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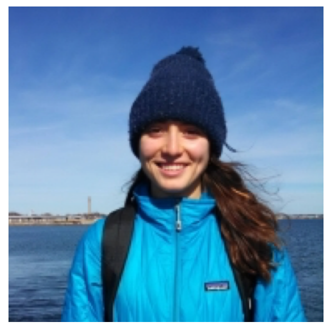
Adele Mortier



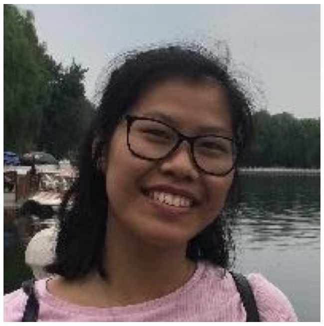
Elise Newman

Undergraduate Research Assistants:

2020-2021 has been an eventful year in our Lab. We are grateful to those who have weathered the storm with us and enabled us to continue our research throughout this period of change. We would like to honor our past and continuing research assistants, without whom this work would have been impossible:

Ella Apostoaie

Katie Dretler



Katherine Chan

Sofia Rubio

Tara Sarma

Elaine Wang

And we welcome our new assistants for this Spring as well:

Meg Allen

Coco Placencia

Jenny Yu

Thank you so much for being on our team!

MIT Language Acquisition Lab, 2021.
Lab Logo by Katie Dretler.