Language & Learning Lab
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Dear Parents,

We would like to thank you all once again for your continued support and participation in our research projects. Over the past year, the Language and Learning Lab has completed several new projects. In this newsletter, we would like to share what we discovered in the studies you and your child participated in. We could not have done this without your help!

For the latest updates on exciting projects your child may be eligible for, please follow us on Instagram @langlearn_uoft! If you know friends or family who might be interested in participating in our research, or would like to update your information or let us know about any new family members, feel free to visit our lab website: http://www.languageandlearninglab.com/.

Our laboratory is always looking for new 'child scientists' to help us with our studies and could not do this important work without the generous support of parents like you!

Sincerely,

The Language and Learning Lab Team
The University of Toronto

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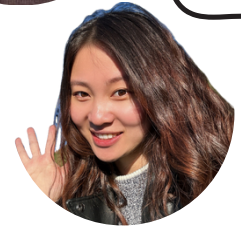

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Facilitating children's problem-solving abilities through exposure to counterfactual scenarios

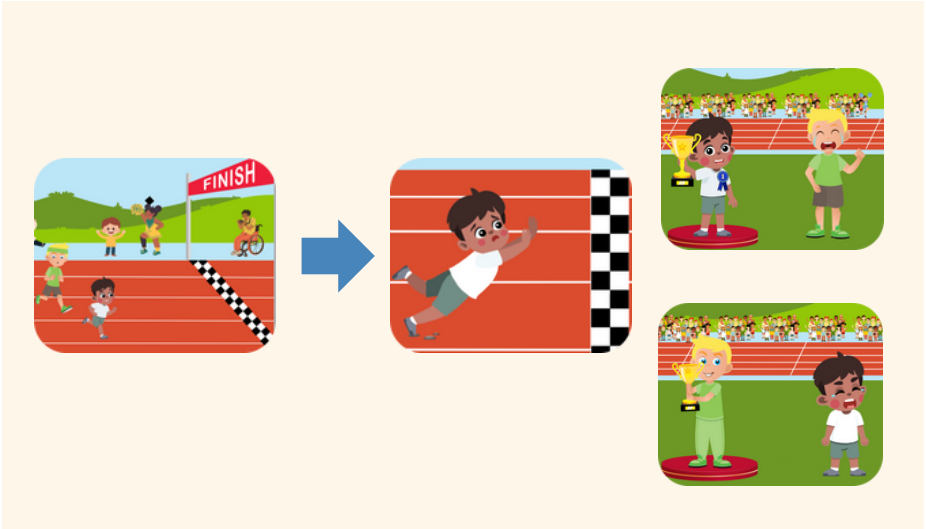
Counterfactual reasoning is the ability to think about "what might have been" to past events we have encountered. By asking "what if" or "if only" questions, this type of reasoning allows us to evaluate alternative possibilities and learn from outcomes to modify future behavior.

For adults, exposure to counterfactual scenarios and considering even just one alternative outcome can expand their imagination, enabling them to think of more possibilities that extend beyond the original situation that triggered the counterfactual thought. As a result, this enhanced ability makes it easier for adults to identify **alternative solutions** when problem-solving in both similar and unrelated situations.

What did we do?

We explored whether exposure to counterfactual scenarios have a similar effect on children's **problem-solving abilities** and whether the **emotional tone** of the story influences this effect

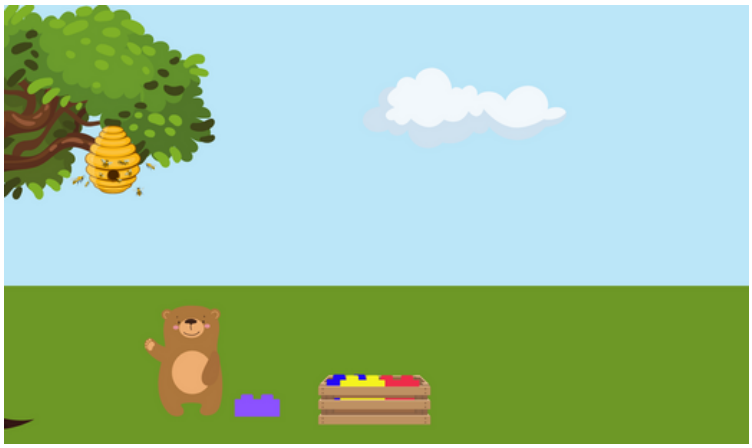
We presented 6- and 8-year-old children with a storybook containing 4 different counterfactual scenarios. After listening to the storybook, children completed 2 different problem-solving tasks.



Problem-solving Tasks

Honey Bear Task

Children were introduced to a character named Mr. Bear who wanted to reach a honeycomb hanging at the top of a tree. Children were tasked with finding a solution for Mr. Bear to reach the honeycomb.



Alternative Uses Task

Children were asked to think of novel uses for ordinary objects like a pencil to assess problem-solving skills by evaluating children's capacity to think flexibly and generate atypical innovative uses

What did we find?

6-year-olds who were presented with counterfactual scenarios performed better in both problem-solving tasks compared to those who were not exposed to counterfactual scenarios. For the **8-year-olds**, exposure to counterfactual scenarios had no effect on their problem-solving abilities, as they performed similarly across conditions. Additionally, they demonstrated better problem-solving skills in general compared to the 6-year-olds. Both 6- and 8-year-old performance was not affected by whether they heard a negative or positive outcome, suggesting that the emotional tone of the story does not impact the outcome.

This study shows that exposure to counterfactual scenarios can help facilitate problem-solving among younger children. Our findings provide insights into incorporating counterfactual reasoning as a tool in interventions to enhance children's problem-solving skills.

Do parents guide children to think about different possibilities?

A lot of our past research has looked at when children can form counterfactual thoughts in activities with experimenters. In this study, however, we were interested in whether and how children and their parents discuss counterfactual possibilities together.

What did we do?

We asked 62 families with children between the ages of 3 and 6 to have conversations with each other about past events. We asked them to talk about one **positive** and one **negative** event they had experienced together. Families (one parent and one child from each) chose to talk about a huge range of different events together, including getting hurt, visits from the Tooth Fairy, lost teddies, and learning to snowboard! We then asked them to consider and discuss how these events could have turned out differently.

What did we find?

What we found is that parents scaffolded - or provided supportive guidance - their children's counterfactual thinking abilities. Parents often introduced a **hypothetical question** such as, "what if you had been going slower?" that children were able to continue or complete ("I wouldn't have fallen."). Together, parents and children generated counterfactual possibilities that children might have had difficulty with on their own. This is just one of the many amazing ways that parents support their children's thinking and reasoning.

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"What if...?": Children's hypothetical thinking about complex systems

We investigated how children aged 5 to 7 understand the impacts of changes within interconnected systems, like food chains. We asked whether children could make **predictions** about the effects of removing one species from an ecosystem on the remaining species. This is an important ability that we engage in when we ask questions such as "What would the world be like with no bees?" and allows us to consider hypothetical changes to our world before they take place, taking steps to prevent them.

What did we do?

We taught children about novel food chains, each with three species, and asked them to predict the effects of removing one species on the remaining two. In some cases, we asked about the effects on a species' direct predator or prey, and in other cases we asked about indirect effects.

For instance, children learned about a desert that was home to sima, ranaes, and fels. They learned that fels eat ranaes, and ranaes eat simas. They were then asked if the fels were removed what would happen to the ranaes (direct effect) and simas (indirect effects).

In another case, children learned about a pond that was home to palas, mingos, and nirks and were asked what would happen if palas, at the bottom of the food chain, were removed.

Seven-year-olds generally understood **both direct and indirect consequences** well, while five-year-olds performed at chance levels. Six-year-olds showed intermediate understanding.

Study 2 confirmed these findings using food chains with clearer constraints. In both studies, children found it easier to reason about **directly connected species** compared to those with indirect connections.

Overall Findings

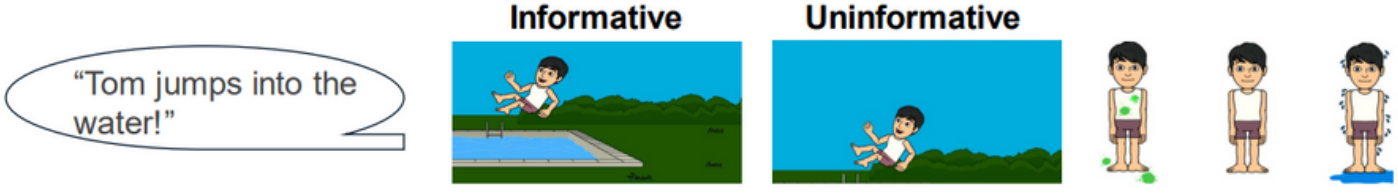
Our results suggest that the ability to think about hypothetical changes in complex systems develops significantly between ages 5 and 7. Understanding this developmental trajectory can help in designing better educational tools for teaching young children about ecological and other dynamic systems.

Young Children's Inferences of Story Outcomes Based on Verbal and Pictorial Information

To comprehend a narrative, we keep track of and update our **mental representations** of the story's situation as it unfolds. This involves creating **inferences**, or guesses, about what might happen next. We wondered whether young children can also grasp a story's narrative by drawing a simple inference using verbal and pictorial information.

What did we do?

We presented two short stories to 2- and 3-year-olds. As the story unfolded, children heard implicit verbal information about the protagonist's physical state. Children saw either an informative picture or an uninformative picture accompanying the implicit verbal information. Children were then asked, "What does Tom look like now?" and chose from three pictures of the protagonist: wet, dry, or covered in paint.



Three-year-olds performed better than 2-year-olds at inferring the story outcome using **implicit verbal information**, regardless of whether the picture was informative or not.

	Explicit Verbal	Implicit Verbal
Picture	(CONTROL) Tom jumps into the pool! He's swimming in the water. Tom is all wet. He's all covered in water. 	Tom jumps into the water! 
No Picture	Tom jumps into the pool! He's swimming in the water. Tom is all wet. He's all covered in water.	Tom jumps into the water!

We also wondered whether 3-year-olds could draw inferences with implicit verbal information alone and whether explicit verbal information would improve 2-year-olds' performance when accompanied by an informative picture. In a follow-up study, 2-year-olds either heard explicit verbal information with a picture, implicit verbal information with a picture, or explicit verbal information without a picture. Three-year-olds heard either implicit or explicit verbal information without a picture.

What did we find?

The explicitness of verbal information or the presence of an informative picture did not improve 2-year-olds' performance. However, older 2-year-olds drew greater appropriate inferences than younger 2-year-olds, regardless of the verbal and pictorial information. 3-year-olds found it easier to draw appropriate inferences with explicit verbal information without a picture compared to implicit verbal information alone. This means that 3-year-olds are still learning to draw inferences from implied information.

In summary, 2- and 3-year-olds are beginning to integrate both **explicit and implicit verbal information** to draw inferences about story outcomes, and providing an informative picture is not necessary for this to happen!

Do children use language in their logical reasoning?

An important question for scientists is whether young children and animals can reason logically without the presence of language or whether language is crucial for the development of logical thought. Previous research has shown mixed findings. A logical reasoning process researcher often use to test these questions is the **"disjunctive syllogism"**.

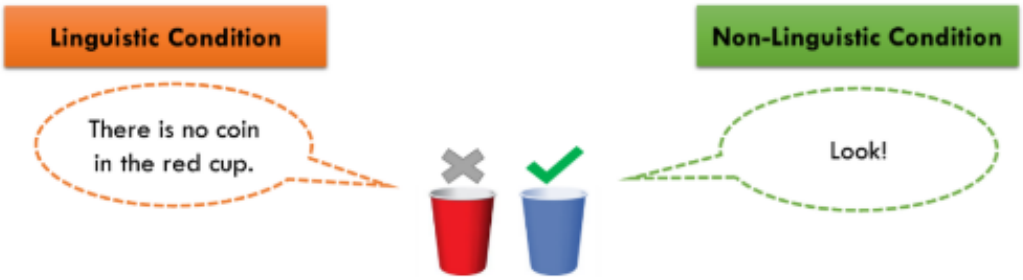
The disjunctive syllogism is a very easy reasoning process for adults, but it is an open question whether young children are capable of such reasoning. In prior work, some research studies show success in children as young as age 3, while others showing success only after age 5.

How the syllogism works

If you have two locations (A and B) and you hide a reward in one location OR the other, then children need to represent the logical relation of disjunction (A OR B). Then, you show children that location A is empty, and they need to represent the logical relation of negation (NOT A). Then, they need to combine these two pieces of information to create a NEW piece of information, the logical conclusion that the reward necessarily must be in location B.

Our studies

We have done a linguistic version of the disjunctive syllogism task, where instead of showing children that one location was empty, we gave them a negative sentence (e.g., there is no coin in the red cup). Unlike prior studies, we found successful reasoning even with 2.5-year-olds! To be certain that it was the presence of language (linguistic negation) that made children in our study succeed earlier than in other studies, we followed-up on this finding by assigning participants in two groups: a group that receives training trials with linguistic negation (e.g., there is no coin in the red cup) and a group that receives training trials with visual negation (i.e., showing them that the red cup is empty). After the short training, both groups performed the non-linguistic version of the disjunctive syllogism task. Results showed that 2.5-year-olds who received the **linguistic training** were more likely to pass the task than those who received the **visual training**. These are the first results to show that logical language facilitates logical reasoning in children.



The role of alternatives in conditional reasoning

When reasoning about conditional sentences, children and adults frequently fall into **reasoning fallacies**. For example, when people hear a sentence like "If the animal is a dog, then it has four legs" and then they are told that "The animal has four legs", they frequently derive the logically erroneous conclusion that "The animal is a dog" (which we know is not true, because many animals other than dogs also have four legs!). This phenomenon is well-documented in the literature and it is believed that it happens because people tend to interpret the word "if" as meaning "if and only if", which makes conclusions like the above true.

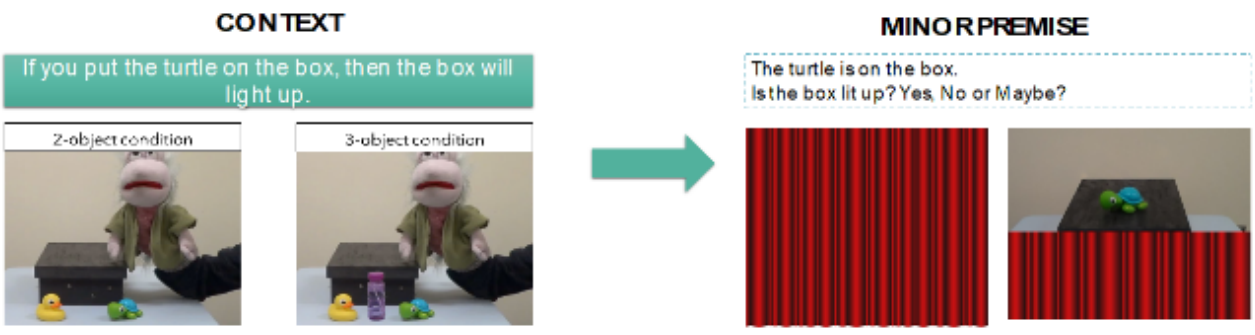
If the animal is a dog, then it has four legs.
Minor Premise: The animal has four legs.
Conclusion: Therefore, the animal is a dog. ✗

Our studies

In our studies, we investigate the conditions under which **reasoning fallacies** with conditionals can be limited in adults and children. We test the possibility that conditional reasoning is affected by people's mental access to alternative scenarios that could render the conditional false.

To test our hypothesis, we presented five-year-olds, seven-year-olds and adults with a box that lights up when you put the 'right toy' on top of it. Half of the participants saw two alternative 'toys' that could make the box light up (2-object condition; e.g., duck, turtle); half were presented with three alternative 'toys' (3-object condition; e.g., duck, turtle, bottle). On every trial, participants heard a conditional statement (e.g., If you put the turtle on the box, then the box will light up), were presented with a minor premise (e.g., the turtle is on the box), and were asked a question with three possible responses (e.g., Is the box lit up? Yes, no or maybe?).

Findings show both adults and children fell into reasoning fallacies when presented with few 'toy's that could make the box light up (2-object condition) but these logical fallacies in adults (but not in children) disappeared when they evaluated **conditional statements** against a broader set of alternatives (in the 3-object condition).



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CURRENT STUDIES

Interested in learning about and contributing to our ongoing work? Check out some of our current studies that your child may be eligible for!

LIGHTBOX STUDY

FOR AGES 4-5

How do children think about events in the past and how they could have turned out differently?

In this study, children will be familiarized with a new toy machine and will be asked questions about how the toy works and how it could have worked differently.

This study takes place **in-person** at our lab!

HYPOTHESIS TESTING

FOR AGES 7-8

Have you ever wondered how your children correct their incorrect beliefs?

In this study, we examine how we can correct scientific misconceptions.

Children will engage in hands on experimentation and answer questions about their scientific beliefs

This study takes place **in-person** at our lab!

Interested in participating?

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