

*"Language learning is something that happens inside our brains, of course, so how do researchers at the **Language and Cognition Lab** figure out what's going on in there? One way is by studying where participants focus their attention when listening to an artificial language."*

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## Learning from your mistakes: Research from the Language and Cognition Lab

By Jordan Whitehouse  
Photos by Garrett Elliott

Kat Snelling played a lot of sports as a kid, and one mantra she heard over and over was, "Perfect practice makes perfect." It makes sense: you don't practise the wrong way, you practise the right way, right? Well, maybe not. As she would later see, when working as a swimming instructor, embracing errors may be a lot more important to the learning process than we think. In the pool, sometimes swimmers need to make the mistake to see that it's wrong – to feel that it's wrong – to be able to correct it.

It was a fascinating realization, and one that's now at the heart of Snelling's own research as a master's student at the Language and Cognition Lab in the Department of Psychology. Her focus now, though, isn't on the front crawl but on how kids and adults learn language. And this is research that could have wide implications. Sure, an error might slow you down temporarily, but in the long term, says Snelling, it could be beneficial to you. "We're finding that English speakers with greater vocabularies are the ones who can quickly recognize when they make a mistake."

No doubt Snelling's thesis supervisor Stanka Fitneva, the director of the Language and Cognition Lab, learned a lot from language errors growing up in Bulgaria. Her first language was Bulgarian, but by grade three, she was learning Russian, and in high school, she studied English, French, and German. It makes sense, then, that language is still fundamental to how Dr. Fitneva views the world and why she started the lab in the first place. It's a hub for studying how we use and learn language.

It's a weighty research focus, and at the Language and Cognition Lab it connects to concerns from developmental, cognitive, and social psychology, as well as linguistics, philosophy, and

sociology. And while there are many factors that contribute to how we learn language, the main focus at the lab is on statistical learning.

Statistical learning is the ability to extract patterns from what we hear and what we see. It is easy to show it at work: everybody recognizes that the letter “e” is more frequent than “t.” And tracking what words and objects occur together may clue us to the meanings of words. Our brains try to find patterns so that we can predict our environment and act appropriately.

## **Predicting the error of our ways**

Researchers believe statistical learning involves making predictions, some of which may be wrong. This is because at any one point, information may be incomplete and ambiguous. “The broader problem that’s been framed in children’s language acquisition,” says Snelling, “is this: if you’re talking to a kid and you say, ‘Look at the bottle,’ how do they know if you’re referring to the bottle or the juice in the bottle, or the table that the bottle is on?” Over time, with more information, learners resolve these problems and correct any errors they have made.

Snelling’s research examines how exactly errors might affect kids and adults learning. For adults, errors may not be a problem, since most of us can take in a lot of information and process it quite quickly. But kids have more limited cognitive abilities than adults. And yet, kids are generally able to pick up a language more easily than adults. So, what’s going on here? That’s partly what Snelling is trying to figure out.

One way she is doing that is by having kids and adults come into the lab to learn an artificial language. Part one of this task is a familiarization phase where she randomly matches made-up words with objects for the participants. In part two, participants are tasked with learning the meaning of the words. They are presented with multiple word-object associations, some of which are the same and some are different from the familiarization phase. “We expect that both children and adults will be able to detect whether the evidence in front of them matches – or does not match – their prediction based on the familiarization.” This might be followed by eliminating the incorrect associations and making a new association. “Our theory is that the faster a learner processes an error, the better their language is.” Snelling is trying to figure out if this is true by tracking her participants’ eye movements to see how quickly they are able to process error and measuring their vocabulary.

The results aren’t in for kids yet, but for adults she found that there was a unique association between error processing speed and their language ability. It remains to be seen whether rapid detection of error is associated with better vocabularies for children.

## **Rising to the challenge**

A somewhat related phenomenon to Snelling’s research being explored at the Language and Cognition Lab is called “desirable difficulty.” This basically means that if a task is made a little bit hard, but not impossible, then it seems that learners have better retention of information. In one study, for example, Dr. Fitneva found that in a language-learning task, adults who made more wrong initial associations between words and their meanings were actually better at learning the language than adults who made fewer of those initial errors.

In a follow-up, Dr. Fitneva studied adults, 10-year-olds, and four-year-olds to see if the same result would hold true across different age groups. Similar to Snelling's study, participants were tasked with learning an artificial language. To begin, participants saw all of the objects that they were going to learn labels for, and they heard all of the words, but sometimes what they saw and heard did not correspond to what they actually had to learn later on. For adults, the result was similar to Dr. Fitneva's previous study – greater accuracy of initial object-label pairing was associated with poorer learning outcomes. But for 10-year-olds, they learned equally well, no matter how accurate the initial pairing was. And for four-year-olds, they actually performed better when the initial object-label pairing was more accurate. That is, they did not derive benefit from difficulty.

It was a fascinating result because it threw into question a traditional notion in psycholinguistics that assumes the same learning mechanisms are available to people from different age groups. Dr. Fitneva's research is not the only one to question this assumption, but it gives her and her colleagues a new avenue of exploration, as it hints at different learning strategies at different points in development. "Preschoolers obviously have more limited memory and weaker attention than adults, so making the task more difficult may actually make it impossible. In our culture, adults also often label things, leaving little opportunity for error. They also often figure new words from the context. Their greater vocabulary, memory capacity, and attention likely allow them to allocate more resources to the learning task once they remark that it's difficult. The addition of these resources is how they may be ending better off when difficulty is greater. And then, as children transition to elementary school, they begin to see language as an object of study, a collection of nouns and verbs, sounds and letters and lots of rules beyond 'Say thank you when you receive a gift.' This may affect how they approach learning new words. So there are many new questions we would like to explore."

## **Which come first: nouns or verbs?**

Third-year psychology undergrad Rahul Patel helped explore one of these avenues last year in the lab – namely, how two-year-olds learn nouns and verbs. The study was driven by the observation that English-speaking kids tend to develop noun vocabulary much faster and earlier than verb vocabulary. Using a similar set-up to the studies already mentioned by Snelling and Fitneva, Patel used eye-tracking data to determine if toddlers would more easily learn nouns or verbs. Although the data still needs to be analyzed more rigorously, the results so far are surprising: the kids actually appear to have learned the verbs more easily than the nouns. "Which is contrary to prior research," says Patel, "English-speaking children have more nouns in their vocabulary compared to verbs, and presumably should learn nouns – object labels – more easily."

## **Beyond the lab**

Patel may participate in the analysis of all of that data he helped collect, but even if he doesn't, he says the year he spent in the Language and Cognition Lab was a big benefit to him academically. Not only did he get experience recruiting participants, communicating with parents, and making kids feel comfortable in the lab – key skills in the developmental psychology research world – but he also ran some of the kids through the learning task. "I have learned more about the developmental field of psychology," he says, "plus how to better interact with children, and basic research methodologies."

Likewise, Kat Snelling's work at the lab has been "huge" to her ongoing academic career in psychology, she says. While she has, for example, received lots of help from Dr. Fitneva and others to improve her writing and rethink her research, one of her most significant takeaways has been how to figure things out on her own. "I've learned so much just by doing and by being independent and accountable for the research. I'm used to being in class where you have a syllabus and it's really structured and you know where to go if you don't know how to do something. Whereas doing research is not like that. You just have to figure out how to get things to work on your own."

Snelling says it's also been fascinating to think about the applications of her research, such as the positive role that those errors could play in different learning environments. She got to do some of that thinking at a couple of conferences this past year where she shared her work with researchers working in a wide variety of fields, including artificial intelligence. "It was a really cool experience to talk to people outside of the Queen's community and see what other people are doing around the world and how my work fits into the broader, more global picture of cognitive development."

Back on campus, Dr. Fitneva says that global picture is something that they all have to think about every day in the Language and Cognition Lab. "Statistical learning is a basic cognitive process that's important not just for language learning. The better we understand it, the better we're going to understand other aspects of how the mind works."

Language learning is something that happens inside our brains, of course, so how do researchers at the Language and Cognition Lab figure out what's going on in there? One way is by studying where participants focus their attention when listening to an artificial language. And as you might guess, that's a lot easier with adults than with kids. Adults can, not only answer a question directly, but also click on a mouse, press a button, or point to indicate what a word means. Then, researchers can examine the accuracy, as well as the speed, of their responses. "Little kids, though, are not really enamoured with keyboards, and we recently discovered that they don't really know what a mouse is," says Stanka Fitneva with a laugh.

So, they use an eye tracker to see where kids look on a computer screen, how quickly they look, and whether they prefer one thing over another. Like something out of an optometrist's office, the eye tracker is integrated into the bottom of the computer screen.

Even snug in a parent's lap, however, little kids will still wiggle and fidget, so the task is shorter for them versus adults. "You try to make the task as interesting as possible, part of a story," says Kat Snelling. "So you might say, 'Okay, we're going up to space, look at the blue planets moving across the screen!'"

Bottom line: when you work with kids, things are driven by them a lot more than with adults. "If they don't want to do it, then they won't and that's totally fine," says Snelling. "You just have to be flexible in accommodating the individual child while still making sure that the data are not affected."