How Children Learn To Read

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BY SEAN GALLUP/GETTY

Why is it easy for some people to learn to read, and difficult for others? It's a tough question with a long history. We know that it's not just about raw intelligence, nor is it wholly about repetition and dogged persistence. We also know that there are some conditions that, effort aside, can hold a child back. Socioeconomic status, for instance, has been reliably linked to reading achievement. And, regardless of background, children with lower general verbal ability and those who have difficulty with phonetic processing seem to struggle. But what underlies those differences? How do we learn to translate abstract symbols into meaningful sounds in the first place, and why are some children better at it than others?

This is the mystery that has animated the work of Fumiko Hoeft, a cognitive neuroscientist and psychiatrist currently at the University of California, San Francisco. "You know where the color of your eyes came from, your facial features, your hair, your height. Maybe even your personality—I'm

stubborn like mom, sloppy like dad," Hoeft says. "But what we're trying to do is find out, by looking at brain networks and accounting for everything in the environment, is where your reading ability originates."

his fall, Hoeft and her colleagues at U.C.S.F. published the results of a three-year longitudinal study looking at the basic neuroscience of reading development. Between 2008 and 2009, Hoeft recruited a group of five- and six-year-old children. Some came from backgrounds predictive of reading difficulty. Others seemed to have no obvious risk factors. In addition to undergoing a brain scan, the children were tested for general cognitive ability, as well as a host of other factors, including how well they could follow instructions and how coherently they could express themselves. Each parent was also surveyed, and each child's home life, carefully analyzed: How did the child spend her time at home? Was she read to frequently? How much time did she spend watching television? Three years later, each child's brain was scanned again, and the children were tested on a number of reading and phonological tests.

When Hoeft took into account all of the explanatory factors that had been linked to reading difficulty in the past—genetic risk, environmental factors, pre-literate language ability, and over-all cognitive capacity—she found that only one thing consistently predicted how well a child would learn to read. That was the growth of white matter in one specific area of the brain, the left temporoparietal region. The amount of white matter that a child arrived with in kindergarten didn't make a difference. But the change in volume between kindergarten and third grade did.

What is white matter? You can think of it as a sort of neural highway in the brain—roads that connect the various parts of the cortex and the brain surface. Information, in the form of electrical signals, runs across the white matter, allowing for communication between the different parts of the brain: you see something, you give it meaning, you interpret that meaning. Hoeft saw an increase in the volume of pathways in the left temporoparietal, which is central in phonological processing, speech, and reading. Or, as Hoeft puts it, "it's where you do the tedious work of linking sounds and letters and how they correspond." Her results suggested that, if the increase in white matter doesn't occur at the critical time, children will have a hard time figuring out how to look at letters and then turn them into words that have meaning.

Hoeft's discovery builds on previous research that she conducted on dyslexia. In2011, she found that, while no behavioral measure could predict which dyslexic children would improve their reading skills, greater neural activation in the right prefrontal cortex along with the distribution of white matter in the brain could, with seventy-two-per-cent accuracy, offer such a prediction. If she looked at over-all brain activation while the children performed an initial phonological task, the predictive power rose to more than ninety per cent. Over-all intelligence and I.Q. didn't matter; what was key was a very specific organizational pattern within your brain.

The group's new findings go a step further. They don't just show that white matter is important. They point to a crucial stage where the development of white matter is central to reading ability. And the white-matter development, Hoeft believes, is surely a function of both nature and nurture. "Our findings could be interpreted as meaning that there's still genetic influence," Hoeft says, noting that preëxisting structural differences in the brain may indeed influence future white-matter development. But, she adds, "it's also likely that the dorsal white-matter development is representing the environment the kids are exposed to between kindergarten and third grade. The home environment, the school environment, the kind of reading instruction they're getting."

She likens it to the Dr. Seuss story of Horton and the egg. Horton sits on an egg that isn't his own, and, because of his dedication, the creature that eventually hatches looks half like his mother, and half like the elephant. In this particular case, Hoeft and her colleagues can't yet separate cause and effect: Were certain children predisposed to develop strong white-matter pathways that then helped them to learn to read, or was superior instruction and a rich environment prompting the building of those pathways?

Hoeft's goal isn't just to understand the neuroscience of how children read. Neuroscience is the tool to figure out a much broader question: How should early reading education work? In another study, which has just been submitted for publication, Hoeft and her colleagues try to turn their understanding of reading ability toward helping to identify the most effective teaching methods that could help develop it. Typically, children follow a very specific path toward reading. First, there is the fundamental phonological processing—the awareness of sounds themselves. This awareness builds into phonics, or the ability to decode a sound to match a letter. And those, finally, merge into full, automatic reading comprehension. Some children, however, don't follow that path. In some cases, children who have problems with basic phonological awareness nonetheless master phonic decoding. There are also children who have problems with the decoding, yet their reading comprehension is high. "We want to use these surprising cases to understand what allows people to be resilient," Hoeft says.

She's studied, in particular, a concept known as stealth dyslexia: people who have all of the makings of dyslexia or other reading problems, but end up overcoming them and becoming superior readers. Hoeft may even be one of them: she suspects that she suffers from undiagnosed dyslexia. As a child in Japan, she had a difficulty with phonological processing very similar to that experienced by dyslexics—but, at the time, the diagnosis did not exist there. She struggled through without realizing until graduate school that a possible explanation for her problem existed in scientific literature. Studying stealth dyslexics, Hoeft posits, could be key to figuring out how to improve reading education more broadly. These stealth dyslexics have reading problems but are able to develop high comprehension all the same.

Hoeft's group, she told me, has found that stealth dyslexics display a unique dorsolateral prefrontal cortex. That's the part of the brain that is responsible, among other things, for executive function and self-control. In stealth dyslexics, it seems to be particularly well-developed. That may be partly genetic, but, Hoeft says, it may also point to a particular educational experience: "If it's superior executive function that is helping some kids develop despite genetic predisposition to the contrary, that is really good news, because that is something we do well—we know how to train executive function." There are multiple programs in place and multiple teaching methods, tested over the years, that help children develop self-regulation ability: for example, the KIPP schools that are using Walter Mischel's self-control research to teach children to delay gratification.

What Hoeft's studies demonstrate is that no matter a kid's starting point in kindergarten, reading development also depends to a great extent on the next three years—and that those three years can be used to teach something that Hoeft now knows to be tied to overcoming reading difficulty. "That might mean that, in the earliest stages, we need to pay attention to that executive function," she says. "We need to start not just giving flashcards, letters, and sounds the way we now do, but, especially if we know someone might be a problem reader, look at these other skills, at cognitive control and self-regulation." Being a better reader, in other words, may ultimately involve instruction around things other than reading.