# The inner workings of the dyslexic brain

Interview by Meeri Kim
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*Neuroscientist John Gabrieli uses brain imaging to discover key differences in children with dyslexia that could point to new interventions.*

Meeri Kim: *You have used brain imaging – methods that probe the structure and function of the living brain – to explore fundamental topics like human emotion, aging, and memory. Today, I'd like to focus on your work in dyslexia. First of all, what is now known about dyslexia, and how has our knowledge of the learning disorder advanced over the years?*

John Gabrieli: Dyslexia, defined as an unexplained difficulty in learning to read, affects 10-12% of children. We used to think that the main problem was with adding a visual component to language — in other words, children were speaking at home in a satisfactory way, but then went to school and had trouble once print was introduced.

Now there is this broad consensus that the most common reason for reading difficulties actually has to do with the processing of spoken language. Some children process spoken language in a way that makes it hard for them to grasp what is called phonological awareness, a skill that allows one to consciously or explicitly understand that a word is made of multiple sounds. Children need to understand the multiple sounds within a word in order to map those sounds onto print and to relate them to the words they know.

MK: *Does this phonological awareness deficit translate to a noticeable difference in brain structure or function?*

JG: In terms of the brain, there's quite a bit of convergent evidence that at least two areas essential for reading function differently and disadvantageously in children who are poor readers. The two spots are both located in the left hemisphere, which is the language hemisphere and becomes dominant for reading with experience. One spot in the left temporal region is specialized for the perception of print, and another in the parietal area is specialized for relating print to sound. Many studies have shown that these areas function differently in children and adults with dyslexia.

Also, compelling evidence exists that some aspects of brain anatomy are different in children with dyslexia, and that those characteristics are evident before they attend school — even within a month of birth.

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MK: *Your lab recently published a study looking at brain plasticity in individuals with dyslexia. What did you find?*

JG: With typically-reading individuals, if something is seen or heard repeatedly, their brain processes it more efficiently each time. We see that efficiency manifested as lowered brain activation in response to the stimuli almost immediately after the second, third, or fourth time that they see or hear something.

But using magnetic resonance imaging (MRI), we observed that adults and children with dyslexia had far less of this adaptation to repeated auditory and visual stimuli, suggesting that the dyslexic brain is more rigid and less plastic. The stimuli included spoken words and print. Less efficient processing of these kinds of information is probably not helpful for learning how to read.

The surprise of the study was that this finding of less plasticity extended even to things like repeated faces and objects, which are not part of reading. It's a bit of a mystery why it would extend this far, since nobody notices individuals with reading difficulty having trouble with faces or objects.

MK: *One of your earlier studies found that people with dyslexia have a harder time identifying voices. Is that result related to less plasticity in the brain as well?*

JG: Yes, and that result actually led us to do this more recent MRI study. We found that individuals with dyslexia had impaired voice-recognition abilities compared to control subjects which made us wonder about the plasticity of the brain that supports learning.

MK: *What is being offered in terms of early intervention for children with dyslexia? Are current interventions helpful?*

JG: There are reading programs for early intervention that involve small groups with an expertly-trained teacher. They help children focus on thinking about the sound units of language, and how they apply to print. So it's more direct instruction. Almost every kid gets some of that in school naturally, as part of the curriculum, but some children just need more support.

## "There is good evidence that these interventions are most effective when they're administered in kindergarten or first grade. And with every passing grade, they become less helpful to students."

There is good evidence that these interventions are most effective when they're administered in kindergarten or first grade. And with every passing grade, they become less helpful to students. So the faster we can bring students to be identified and given support, the more they can be helped.

Unfortunately, we have a system that's often based on a sort of "wait to fail" model, where well-intentioned teachers in schools often can't quite decide if students have a reading problem until they're so far behind that it becomes a crisis. And that's a huge loss because not only are these children forgoing early intervention, but they often feel very defeated about their capacity to do well in school. If they're far behind their peers and really struggling, instead of being confident and optimistic learners, they're often very unsure about their school abilities.

MK: *Do you believe your findings could be used to improve on current interventions?*

JG: In the future, if we could identify brain differences near birth, there could be an entire new generation of interventions even done at home. Although this is exploratory, it would open up the possibility of support before the child even gets to school.

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There is some amazing research going on in animals — and this is not ready for people — for developing medications that promote plasticity. It's hard to imagine that a medicine would work on language directly, but a medicine that works on promoting a bit of plasticity is not out of the question.

However, one would have to think cautiously in terms of the ethics of such a treatment before implementing it in humans.

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