Brain Volume in Children Increases from Dyslexia Training

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If a car is repaired and runs better, you can see the changes by looking under the hood. The same applies to "fixing" the brain.

Investigators at Georgetown University Medical Center have shown that an educational intervention that helps children overcome dyslexia actually results in an increase in the brain's gray matter.

Using neuroimaging, a research team found that 11 children with dyslexia who participated in an eight-week long reading intervention program gained gray matter volume in four areas of their brain that relate to memory and mental imagery. These changes in brain structure remained intact when measured two months after the training, as did the improvements seen in reading skills.

Their study, reported in the August issue of the journal *NeuroImage*, is the first to show these kinds of changes in gray matter in dyslexic children, says the study's senior investigator, **Guinevere Eden, DPhil**, professor, **Department of Pediatrics**, and director, **Center for the Study of Learning (CSL)**.

"There was a significant expansion — up to four percent — in the gray matter volume of these areas," says Eden, who is also president of the International Dyslexia Association.

The study's lead author, **Anthony Krafnick**, a graduate student in the **Interdisciplinary Program in Neuroscience**, has long been interested in helping people who struggle with reading and language. "It is important to me that my research has the potential to positively impact the community as a whole," he says.

Dyslexia is a reading disorder that arises because an individual's brain is not able to accommodate the reading process, which is a trained skill, in the same way as other people, says Eden. But it can be effectively addressed with intervention, especially as soon as symptoms of reading difficulty become apparent in children. These interventions are aimed at improving language-related and cognitive skills, and many have shown success.

But no one has attempted to show the "gray matter correlates" of that change, says Krafnick. So he and Eden and their colleagues (Lynn Flowers, PhD, a neuropsychologist at Wake Forest University and **Eileen Napoliello**, of CSL) designed and conducted a study to see if there are, in fact, discernable anatomical brain changes after use of a well-tested program. They borrowed the principles of a new and rapidly emerging field known as "educational neuroscience" — looking under the brain's hood to see if an educational program is working.

The researchers enrolled dyslexic children from a Baltimore-based school, The Jemicy School, in a reading intervention. Before and after the program, the children participated in a magnetic resonance imaging (MRI) scan, which provides a high resolution anatomical image of the brain. Voxel-based morphometry, which is a neuroimaging analysis technique, was then used to investigate changes in brain anatomy following intensive tutoring of the students.

The intervention focused on the relationship between letters and groups of letters and the sounds they make, according to Eden. It used a 'multi-sensory' approach that included mental tracing of letters while simultaneously naming the letter.

The researchers found, after the final scan, that some of the reading skills improvements were directly correlated with the changes in brain structure. New skill at identifying sounds within words was related to increased volume in a part of the brain called the precuneus, which is involved in the mental imagery used in the intervention, Krafnick says. Improvement in reading pseudowords (words that aren't real, but are pronounceable) was related to increased volume in part of the cerebellum, which can be active during various language related tasks.

Eden calls the results "really exciting. When the children get better at reading, you know the neural substrates that are responding. You can see the brain areas involved, and these results can theoretically help improve training," she says. "The intervention can be continually improved after understanding what effects they have on the brain."

"We know these reading interventions work," says Krafnick. "And now we can see the evidence in the brain."

By Renee Twombly, GUMC Communications

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