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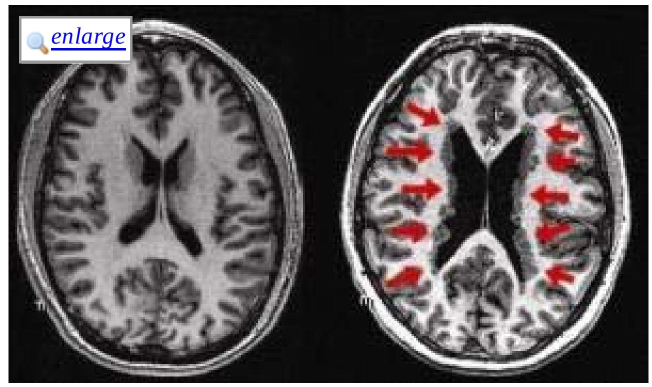
Slow Reading In Dyslexia Tied To Disorganized Brain Tracts

ScienceDaily (Dec. 4, 2007) — Dyslexia marked by poor reading fluency -- slow and choppy reading -- may be caused by disorganized, meandering tracts of nerve fibers in the brain, according to researchers at Children's Hospital Boston and Beth Israel Deaconess Medical Center (BIDMC). The study, using the latest imaging methods, gives researchers a glimpse of what may go wrong in the structure of some dyslexic readers' brains, making it difficult to integrate the information needed for rapid, "automatic" reading.



In a normal brain (left), white matter (light gray) is in the interior, and gray matter (dark gray) is mostly on the surface. In patients with periventricular nodular heterotopia (right), clumps of gray matter, called nodules (red arrows), appear deep within the brain, instead of on the surface. (Credit: Bernard Chang, Beth Israel Deaconess Medical Center)

The study was led by Christopher Walsh, MD, PhD, chief of the Division of Genetics at Children's Hospital Boston, and Bernard Chang, MD, a neurologist at BIDMC.

"We looked at dyslexia caused by a particular genetic disorder, but what we found could have implications for understanding the causes of dyslexia in other populations as well," says Walsh, who is also a Howard Hughes Medical Institute investigator at BIDMC.

Dyslexia, which affects 5 to 15 percent of all children, has different forms. Subjects in the study had reading problems caused by a rare genetic disorder known as periventricular nodular heterotopia, or PNH. Although their intelligence is normal, people with PNH have trouble reading fluently, or smoothly, lacking the rapid processing necessary for this aspect of reading.

The genetic mutation that causes PNH disrupts brain structure. In a normal brain, much of the gray matter (consisting mostly of nerve cells) appears on the brain's surface, while white matter (consisting mostly of nerve fibers or "wiring" connecting areas of gray matter) runs deeper in the brain. In PNH, nodules of gray matter sit deep in the brain's core, in the white matter, having failed to migrate out to the surface as the brain was developing.

To learn more about how these developmental changes in the brain might lead to reading problems, the researchers tested cognitive skills needed for reading in 10 patients with PNH, 10 individuals with dyslexia without neurological problems, and 10 normal readers. They used a specialized form of MRI called diffusion tensor imaging to look at the structure of the white matter in the brain.

In PNH patients, unlike in normal readers, white matter fibers took circuitous routes around the misplaced gray matter, and in some cases, didn't organize into uniform bundles, which could leave regions of gray matter poorly connected. Importantly, the more disorganized the PNH patients' white matter, the less fluent their reading.

While other studies have found disorganized white matter in the general population of people with dyslexia, these individuals often struggle with several aspects of reading, making it "hard to know exactly what the role of white-matter integrity is in isolation," says Chang. By demonstrating white-matter problems in PNH patients, who have an isolated reading fluency problem, and correlating that with reading fluency scores, the researchers were able to conclude that white-matter integrity and organization may be the structural basis in the brain for reading fluency.

"This makes sense," says Chang. "When we read, we need to take in information visually, hook it up with our inner dictionary of what letters and words mean, and when we're reading aloud, connect that with the region that gives us our ability to speak." For smooth, automatic reading, "the white matter is there to connect different regions of gray matter and allow them to function seamlessly." When reading fluency is the primary problem, "it may be that the areas of the brain that are important for reading are not connected efficiently," says Chang.

Most people with dyslexia who have trouble reading fluently don't have misplaced gray matter or PNH. But Walsh and Chang believe that disorganized white matter could similarly alter brain function in both groups. Their next study will examine how faulty white-matter connections alter brain patterns, comparing brain activation during reading in PNH patients and in dyslexic readers with poor fluency, who do not have PNH.

"Our findings suggest that white matter integrity plays a critical role in reading fluency and that defects in white matter serve as the structural basis for the type of dyslexia we see in this brain malformation," said the study's lead author Bernard S. Chang, MD, with Harvard Medical School in Boston, and member of the American Academy of Neurology. "Our work highlights the importance of studying white matter structure in order to understand cognitive problems and learning disabilities more fully."

Pinpointing the brain structures responsible for fluent reading may eventually help researchers and educational specialists develop and use techniques that help improve the automatic nature of reading in children and adults with these kinds of difficulties, the researchers note.

Findings will appear in the journal Neurology on December 4. The study was funded by the National Institutes of Health and the Mind-Brain-Behavior program at Harvard University.

***Editor's Note**: This article is not intended to provide medical advice, diagnosis or treatment.*

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