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Brain Imaging Study Shows Physiological Basis of Dyslexia

ScienceDaily (Sep. 28, 2011) — Researchers at the Stanford University School of Medicine have used an imaging technique to show that the brain activation patterns in children with poor reading skills and a low IQ are similar to those in poor readers with a typical IQ. The work provides more definitive evidence about poor readers having similar kinds of difficulties regardless of their general cognitive ability.

Schools and psychologists have historically relied on a child's IQ to define and diagnose dyslexia, a brain-based learning disability that impairs a person's ability to read: If a child's reading achievement was below expectation based on IQ, he would be considered dyslexic, while a poor reader with a low IQ would receive some other diagnosis. But these new findings provide "biological evidence that IQ should not be emphasized in the diagnosis of reading abilities," said Fumiko Hoeft, MD, Ph.D, an instructor at Stanford's Center for Interdisciplinary Brain Sciences Research, who is senior author of the study, which will appear in an upcoming issue of *Psychological Science*.

The new results come in the wake of recent behavioral studies showing that phonological deficits -- that is, difficulties in processing the sound system of language, which often leads to difficulties in connecting the sounds of language to letters -- are similar in poor readers regardless of IQ. Indeed, the 2004 reauthorization of the Individuals with Disabilities Education Act mandated that states no longer require school districts to use IQ tests in identifying individuals with learning disabilities such as dyslexia.

"There's a disassociation between what is established in research and what is happening in practice," said Hoeft, explaining that many U.S. schools still rely on a discrepancy between reading achievement and IQ to define and diagnose dyslexia. At first glance, she added, it would seem to make sense that poor readers with typical IQs would have different learning challenges than those with low ones.

The use of IQ in diagnosing dyslexia, which affects 5 to 17 percent of U.S. children, has real implications for poor readers. If children aren't diagnosed as dyslexic, they don't qualify for services that a typical dyslexic does, and they're not taught strategies to overcome specific problems in the way they view and process words.

To further understand what happens in the brains of poor readers with different IQs, Hoeft turned to imaging. She and her colleagues expected poor readers with typical IQs to exhibit similar patterns of brain activation as poor readers with low IQs. Their experiments, she said, were intended to confirm that the two groups had the same

neurophysiological basis for impaired phonological processing and that their reading problems were not related to IQ.

The study involved 131 children, ranging from 7 to 16 years old, from Allegheny County, Penn., and the San Francisco Bay Area. The children were put into three groups: poor readers with typical IQ, poor readers with low IQ and typical readers with typical IQ. The children then took a reading test and underwent a brain-imaging technique called functional magnetic resonance imaging, or fMRI, as they completed a task that involved judging whether two visually presented words rhymed (e.g., bait and gate) or not (e.g., price or miss).

In both samples, the typical readers had significantly higher reading-related scores and more accurate performance on the rhyme-judgment task than the two other groups. And there were no significant differences between the two groups of poor readers on these measures.

In the fMRI analysis, researchers found that both groups of poor readers exhibited significantly reduced activations relative to typical readers in the left inferior parietal lobule and left fusiform gyrus. The researchers also used a sophisticated analysis to determine that the brain patterns of each group of poor readers looked liked those of the other group of poor readers more than 80 percent of the time, and did not often resemble the patterns from the normal readers.

Hoeft noted that the results are timely. The Diagnostic and Statistical Manual of Mental Disorders, the standard diagnostic guide for mental illnesses and brain disorders, is currently being revised, and there is a proposal to change it so that IQ wouldn't be taken into consideration when diagnosing dyslexia. (The new version, DSM V, will be released in 2013.) This work, she said, is the, "first study reporting biological neuroimaging evidence to support" that change.

"Convergent psychological, educational and now neurobiological evidence suggests that the long-standing and widely applied diagnosis of dyslexia by IQ discrepancy is not supported," the researchers wrote in the paper.

Hoeft and her colleagues also point out that these and other findings indicate that, "any child with a reading difficulty, regardless of his or her general level of cognitive abilities (IQ), should be encouraged to seek reading intervention."

Hoeft said she will continue her work in this area and is hoping to use imaging to predict outcomes of poor readers. She also plans to look at younger readers to see if imaging can be used to diagnose children at younger ages.

The study's two lead authors are Stanford graduate student Hiroko Tanaka and Jessica Black, Ph.D, of Boston College. The other Stanford co-authors are graduate student Leanne Stanley; Shelli Kesler, Ph.D, assistant professor of psychiatry and behavioral sciences; and Allan Reiss, MD, the Howard C. Robbins Professor of Psychiatry and Behavioral Sciences, a professor of radiology and the director of Stanford's Center for Interdisciplinary Brain Sciences Research. Researchers from the Massachusetts Institute of Technology are also co-authors.

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1. John D. E. Gabrieli, Fumiko Hoeft, Hiroko Tanaka, Jessica M. Black, Leanne M. Stanley, Shelli R. Kesler, Allan L. Reiss, Charles Hulme and Susan Whitfield-Gabrieli. **The Brain Basis of the Phonological Deficit in Dyslexia is Independent of IQ**. *Psychological Science*, 2011

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