Fiber-optic pen helps see inside brains of children with learning disabilities

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Todd Richards demonstrates the pen and pad device while inside the fMRI. Credit: Center on Human Development and Disability

For less than $100, University of Washington researchers have designed a computer-interfaced drawing pad that helps scientists see inside the brains of children with learning disabilities while they read and write.

The device and research using it to study the brain patterns of children will be presented June 18 at the Organization for Human Brain Mapping meeting in Seattle. A paper describing the tool, developed by the UW's

Center on Human Development and Disability, was published this spring in *Sensors*, an online open-access journal. "Scientists needed a tool that allows them to see in real time what a person is writing while the scanning is going on in the brain," said Thomas Lewis, director of the center's Instrument Development Laboratory. "We knew that fiber optics were an appropriate tool. The question was, how can you use a fiber-optic device to track handwriting?"

To create the system, Lewis and fellow engineers Frederick Reitz and Kelvin Wu hollowed out a ballpoint pen and inserted two optical fibers that connect to a light-tight box in an adjacent control room where the pen's movement is recorded. They also created a simple wooden square pad to hold a piece of paper printed with continuously varying color gradients. The custom pen and pad allow researchers to record handwriting during functional magnetic resonance imaging, or fMRI, to assess behavior and brain function at the same time.Other researchers have developed fMRI-compatible writing devices, but "I think it does something similar for a tenth of the cost," Reitz said of the UW system. By using supplies already found in most labs (such as a computer), the rest of the supplies – pen, fiber optics, wooden pad and printed paper – cost less than $100.The device connects to a computer with software that records every aspect of the handwriting, from stroke order to speed, hesitations and liftoffs. Understanding how these physical patterns correlate with a child's brain patterns can help scientists understand the neural connections involved.

Researchers studied 11- and 14-year-olds with either dyslexia or dysgraphia, a handwriting and letter-processing disorder, as well as children without learning disabilities. Subjects looked at printed directions on a screen while their heads were inside the fMRI scanner. The pen and pad were on a foam pad on their laps.

Subjects were given four-minute blocks of reading and writing tasks.

Then they were asked to simply think about writing an essay (they later wrote the essay when not using the fMRI). Just thinking about writing caused many of the same brain responses as actual writing would.

"If you picture yourself writing a letter, there's a part of the brain that lights up as if you're writing the letter," said Todd Richards, professor of radiology and principal investigator of the UW Integrated Brain Imaging Center. "When you imagine yourself writing, it's almost as if you're actually writing, minus the motion problems."

Richards and his staff are just starting to analyze the data they've collected from about three dozen subjects, but they have already found some surprising results.

"There are certain centers and neural pathways that we didn't necessarily expect" to be activated, Richards said. "There are language pathways that are very well known. Then there are other motor pathways that allow you to move your hands. But how it all connects to the hand and motion is still being understood."

Besides learning disorders, the inexpensive pen and pad also could help researchers study diseases in adults, especially conditions that cause motor control problems, such as stroke, multiple sclerosis and Parkinson's disease.

"There are several diseases where you cannot move your hand in a smooth way or you're completely paralyzed," Richards said. "The beauty is it's all getting recorded with every stroke, and this device would help us to study these neurological diseases."

Provided by University of Washington

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