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Having the right timing 'connections' in brain is key to overcoming dyslexia

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Using new software developed to investigate how the brains of dyslexic children are organized, University of Washington researchers have found that key areas for language and working memory involved in reading are connected differently in dyslexics than in children who are good readers and spellers.

However, once the children with dyslexia received a three-week instructional program, their patterns of functional brain connectivity normalized and were similar to those of good readers when deciding if sounds went with groups of letters in words.

"Some brain regions are too strongly connected functionally in children with dyslexia when they are deciding which sounds go with which letters," said Todd Richards, a UW neuroimaging scientist and lead author of a study published in the current issue of the *Journal of Neurolinguistics*. "We had hints in previous studies that the ability to decode novel words improves when a specific brain region in the right hemisphere decreases in activation. This study suggests that the deactivation may result in a disconnection in time from the comparable region in the left hemisphere, which in turn leads to improved reading. Reading requires sequential as well as simultaneous processes."

Richards and co-author Virginia Berninger, a neuropsychologist, said temporal connectivity, or the ability of different parts of the brain to "talk" with each other at the same time or in sequence, is a key in overcoming dyslexia.

Berninger, who directs the UW's Learning Disabilities Center, compared dyslexia to an orchestra playing with an ineffective conductor who does not keep all the musicians playing in synchrony with each other.

"You have all of the correct instruments but, if the conductor is not doing his or her job of coordination, the right instruments are playing at the wrong time," she said. "This all goes away once the conductor finds a way to signal to the musicians to play at the proper times."

The UW researchers used functional Magnetic Resonance Imaging, or fMRI, to explore brain connectivity. This type of imaging typically shows which parts of the brain are activated but does not indicate how they are connected. However, software developed by Richards, a professor of radiology, enabled the researchers to see brain activity in a specific region, the left inferior front gyrus. This region may serve as the "orchestra conductor" for language. The software also provided a look at how this brain area was connected to a similar region in the right hemisphere. The software and the focus on language centers allowed the researchers to collect data that was not related to the children's heartbeat or breathing.

To explore brain connectivity, the researchers worked with 18 dyslexic children (5 girls and 13 boys) and 21 children (8 girls and 13 boys) who were good readers and spellers. All of the children were of normal intelligence and were in the fourth through sixth grades.

The children had to judge whether groups of pink highlighted letters in pairs of nonsense words could or could not represent the same sound. For example, the letters ea and ee in "pleak" and "leeze" could have the same sound but the ea and eu in "pheak" and "peuch" could not. The children's brains were scanned and then those with dyslexia participated in a three-week program that taught the children the code for connecting letters and sounds with an emphasis on timing. Then the children's brains were scanned again.

Following the treatment, the fMRI scans showed that the patterns of temporal connectivity in brains of the dyslexic children had normalized and were similar to those of the good readers and spellers. In particular, the researchers found that connectivity appeared to be normal between the left inferior frontal gyrus and the right inferior frontal gyrus. The left inferior frontal gyrus is believed to control the functional language system, especially for spoken words, while the right inferior frontal gyrus may be involved in controlling the processing of letters in written words. Prior to the treatment these two areas were overconnected and the left inferior frontal gyrus also was overconnected to the middle frontal gyrus, which is involved in working memory that requires temporal coordination.

"These results might mean that after special teaching the children with dyslexia activated letters in written words first and then switched to sounds in spoken words rather than simultaneously activating both letters and sounds," said Richards. "The overconnection between the language conductor and working memory at the same time may be a signal that working memory is overtaxed. When language processing is more efficient after treatment, working memory does not have to work as hard.

"There is this myth that English is an irregular language," added Berninger. "That's not true. We have a set of alternative ways of spelling the same sounds but this is not taught explicitly. The way phonics is often taught over focuses on single letters and not the letter groups that go with sounds as well. Teaching children with dyslexia to read requires a different approach, one that stresses knowledge of spelling-sound relationships with a twist that tweaks the letter and sound processes to get connected in time in the brain."

The researchers caution that the intervention treatment is not a cure for dyslexia. They said it makes children better readers during specialized instruction, but has not been proven over a long period of time, something they hope to do in the future.

"We have shown that gains can maintain for up to two years with behavior measures, but much research is needed before it can be demonstrated that functional brain connectivity can be maintained," said Berninger.

Source: University of Washington

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