New dyslexia theory blames 'noise'

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The dyslexic brain struggles to read because even small distractions can throw it off, according to a new model of dyslexia emerging from a group of recent studies.

The studies contradict an influential, 30-year-old theory that blamed dyslexia on a neural deficit in processing the fast sounds of language.

Instead, the studies suggest that children with dyslexia have bad filters for irrelevant data. As a result, they struggle to form solid mental categories for identifying letters and word sounds.

Such children may benefit from intensive training under "noisy" conditions to strengthen their mental templates, said University of Southern California neuroscientist Zhong-Lin Lu.

Lu was a co-author on three studies, along with lead author and former USC graduate student Anne Sperling (now at the National Institute of Mental Health), USC psychologist Franklin Manis and University of Wisconsin, Madison psychologist Mark Seidenberg.

The most recent study is due to be published later this month in *Psychological Science*.

Confusion about dyslexia rivals the confusion of dyslexia. Many still think that to have dyslexia means to mix up your letters (one of many possible symptoms having to do with word recognition, directional ability and decoding of symbols).

What is known is that dyslexia affects millions of children, with estimates of its incidence ranging from 5 to 15 percent.

Sperling, who conducted her research as a doctoral student at USC, said the new findings point to a deeper problem - not just a visual deficit - affecting all areas of perception.

Sperling said people with dyslexia appear to have shaky mental categories for the essential sounds that make up language.

"It's harder to make a [language] task automatic when your categories are fuzzier than they ought to be to begin with," she said.

"In terms of treatment, the results suggest that programs that foster the development of sharper perceptual categories for letters and letter sounds might be a good way to supplement existing dyslexia interventions," she added.

Lu said, "Train them in noise."

The new study in Psychological Science builds on similar results published by the team of Sperling, Lu, Manis and Seidenberg last year in *Nature Neuroscience*.

In addition, the same authors previously showed that poor readers also have trouble figuring out categories in simple card games.

Other recent studies lend support to the noise exclusion theory.

Johannes Ziegler of the Universite de Provence in Marseille, France, was the lead author on a study of dyslexia and auditory noise published this year in *Proceedings of the National Academy of Sciences*.

Ziegler said his results suggest that dyslexia stems from shaky categories for phonemes (the basic sounds of language).

"In silence, information is often redundant and dyslexics get away with the perception deficit," Ziegler said in an e-mail. "In noise, however, they can no longer compensate.

"What is important is that noisy environments are the rule and not the exception," he added, citing a study from South Bank University in the U.K. that found average noise levels in primary classrooms to be as high as near a busy intersection.

"What Sperling and Lu's data suggest is that the mechanism responsible for faulty phonological
development is quite general and has to do with attention in a broad sense....

"This is a great paper of very high significance... As people like Steve Grossberg [of Boston University] have argued for many years, attention ... is crucial for stable learning of categories."

Ziegler called for preventive training for children with weak speech perception in noise in kindergarten or early primary grades, saying they are at greater risk for developing dyslexia.

He also cited a Northwestern University study from 2003 that documented negative effects from noise on children with learning deficits.

Lu said there is a "lot of evidence" of learning problems from ambient noise. In one such study, Manis and a collaborator from UCLA found that children with dyslexia struggled to discriminate similar sounds, like "spy" and "sky," because they weighed irrelevant differences in sounds

equally with key distinctions.

Manis also cited research from Finland and the United States showing that infants with dyslexic parents lag behind their peers in forming categories for speech sounds.

In the conclusion to their study in Psychological Science, the authors speculate that the deficit in noise exclusion may have biochemical roots in abnormal levels of GABA, a neurotransmitter that helps the brain to filter out irrelevant information.

"This may become interesting for drug development," said Lu, who is testing this hypothesis with functional magnetic resonance imaging trials.

Lu and his collaborators interpret the new results as a rejection of the "magnocellular hypothesis" - named for a type of neuron involved in processing fast visual information - that influenced dyslexia research for decades.

The researchers found that the magnocellular pathway works normally both in children with dyslexia and in adult poor readers - as long as visual or aural noise is low.

As external noise goes up, the same subjects begin to score poorly on visual pattern tests.

The deficit persists even when the task requires only slow processing.

"The findings, and particularly the [slow processing] ones, are consistent with the hypothesis that ... dyslexic children have difficulty setting their signal filters to optimum and ignoring distracting noise," Lu said at the time of the *Nature Neuroscience* study.

The new study in *Psychological Science* was designed to replicate visual tests on motion perception from seminal experiments in the 1970s, with the addition of variable external noise. It also found no magnocellular deficit.

"These were the stimuli people used to establish the magnocellular hypothesis," Lu said. "This is a more direct test of what we said before [in the *Nature Neuroscience* study], which used different spatial and temporal patterns."

Source: University of Southern California