For Reading Development, Auditory Processing Is Fundamental

By Nina Kraus, PhD, & Samira Anderson, AuD, PhD

As audiologists, we understand the important role hearing sensitivity plays in the development of reading skills. What we don't always consider, however, is the effect of central auditory processing.

The accurate representation of speech sounds is an important aspect of learning to link sounds with orthographic symbols, a fundamental building block of reading (*Proc Natl Acad Sci U S A* 2010;107[17]:7939-7944).

Furthermore, if a child is not making sound-to-meaning connections in language, then efficient, automatic representation of sound by the auditory system will not develop. It stands to reason that the evaluation of auditory-processing abilities, in addition to basic hearing thresholds, is an important part of the assessment of children who are having difficulty reading.

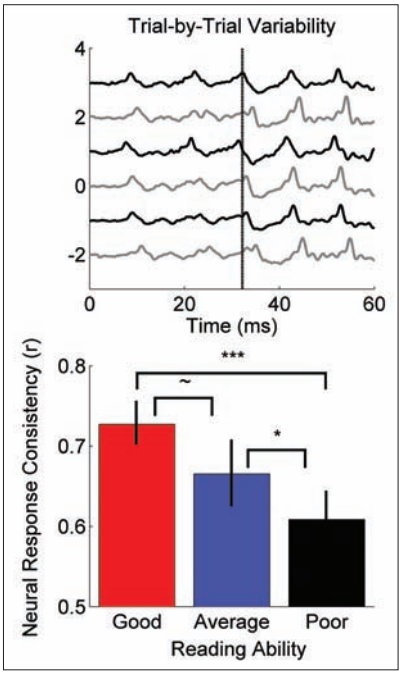
RESPONSE CONSISTENCY

Inpairments in frequency modulation, speech perception, and phonological awareness in kindergarteners and first graders predict a dyslexia diagnosis in third grade (*Res Dev Disabil* 2011;32[2]:560-570). Speech perception in children with dyslexia is particularly problematic in noise (*Dev Sci* 2009;12[5]:732-745), and temporal-processing deficits appear to underlie at least some types of dyslexia, with training leading to improvements (*Science* 1996;271[5245]:77-81).

One of the mechanisms influencing the development of auditory skills and the quality of sound representation is the trial-to-trial consistency of neural responses. If there is jitter or asynchrony, the response will be degraded, resulting in an absent auditory brainstem response (ABR).

Asynchronous firing may degrade the response to the extent that it interferes with reading. In fact, this effect was demonstrated in a rat model of dyslexia (*Cereb Cort* 2013; doi:10.1093/cercor/bht028).

Rats were genetically engineered to have reduced expression of *KIAA0319*, since mutations of this gene are associated with dyslexia. The rats had lower trial-to-trial consistency and reduced discrimination of speech sounds, providing evidence that decreased expression of the *KIAA0319* gene can lead to impaired phoneme processing in the cerebral cortex.



*Top panel: These single-trial responses to a speech syllable illustrate trial-to-trial variability in the ABR of a child with dyslexia. Bottom panel: Good readers have better neural response consistency than average or poor readers. ***p < 0.005, *p < 0.05, ~p < 0.10. (Adapted from* J Neurosci *2013;33[8]:3500-3504. Adaptations are themselves works protected by copyright. In order to publish this adaptation, authorization must be obtained both from the copyright owner in the original work and from the copyright owner in the translation or adaptation.)*

The importance of neural response consistency was also recently demonstrated in children who had a wide range of reading abilities. Those with good reading scores had higher trial-to-trial consistency in the auditory brainstem response to a speech syllable than did children with poor reading scores (*J Neurosci* 2013;33[8]:3500-3504). Overall, these results provide convincing objective evidence for underlying auditory-processing deficits in at least some children with reading disorders.

This study has important implications. Response consistency—an objective measure of auditory processing that reflects neural synchrony—appears to be an important factor in the development of successful reading. Because response consistency is an ABR measure, it would be feasible to incorporate it into the audiological battery.

But let's take this a step further. Are there efficacious treatments for individuals with biological evidence of auditory-processing disorders?

There is now support for the benefits of using FM systems for improving both reading performance and neural response consistency (*Proc Natl Acad Sci U S A* 2012;109[41]:16731-16736). This and other studies evaluating treatment strategies for children with language-based learning impairments will be discussed in the November issue of *The Hearing Journal*.

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