Toward a Biologic Index of APD

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

Awareness of auditory processing disorder (APD) among parents and educational professionals is rising, along with the demand for diagnostic and treatment services. Still, few audiologists perform these evaluations themselves or even refer patients with suspected APD to audiologists who do.

While many reasons exist for this lack of interest or acceptance, the chief reason is that the tests in the available battery do not have good sensitivity or specificity.

But how can a test have good sensitivity or specificity when no gold standard exists? Many of the early APD tests were verified in adults with known lesions. Typically, in children, APD neither is associated with a lesion nor can be verified with neuroimaging or surgery.

A MATTER OF NEURAL TIMING

APD has similarities with auditory neuropathy spectrum disorder (ANSD). Some people with ANSD have normal audiometric thresholds but trouble understanding speech, especially in background noise.

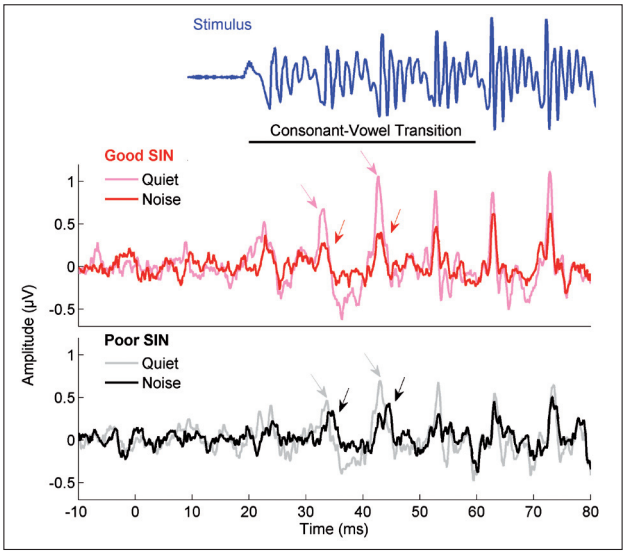
If a person with ANSD reports hearing difficulties but has no testing beyond the audiogram and speech perception in quiet, the diagnosis can be missed. Auditory brainstem response (ABR) testing or electrocochleography (ECochG) is needed to detect the disorder.

Similarly, APD can be missed by the typical audiometric evaluation, but, in this case, the standard ABR or ECochG results are usually normal. The stimuli used in these tests do not pick up subtler timing deficits that may be present in APD.

In contrast, the auditory brainstem response to complex sounds (cABR) is a more sensitive measure of neural timing. Children with learning disabilities have delayed peak timing compared with children who are typically developing in the cABR, but not in the click-evoked ABR (*Audiol Neurotol* 2006;11[4]:233-241).

Similarly, children who are poor readers have reduced trial-to-trial response consistency in the cABR compared with children who are good readers, while there are no group differences in their responses to clicks (*J Neurosci* 2013; 33[8]:3500-3504).

Because children with APD often have difficulty understanding speech in noise, it might make sense to evaluate their processing of such speech using an objective method free from the language, memory, and attention demands that can complicate behavioral APD testing.



Top panel: The stimulus waveform of the syllable /da/ (first 80 ms) is temporally aligned so that the onset and peaks match the responses in the bottom two panels. Individual responses are displayed for a 10-year-old boy with a good HINT score in quiet (pink) and noise (red), middle panel, and for a 9-year-old boy with a poor HINT score in quiet (gray) and noise (black), bottom panel. The arrows illustrate the delay in noise peaks seen in the responses of the child with the poor score.

We and our coauthors recorded responses to the speech syllable /da/ in quiet and in six-talker babble noise (*J Neurosci* 2010;30[14]:4922-4926) in children who had good and poor scores on the Hearing in Noise Test (HINT; *J Acoust Soc Am* 1994;95[2]:1085-1099). We found that children with poor scores on the HINT had greater noise-induced peak timing delays than children with good scores.

The delays were found in the consonant-vowel transition peaks but not for the peaks in the response region corresponding to the unchanging vowel (see the figure).

Although the children in the study did not have a diagnosis of APD, one can see how the cABR can inform APD assessment. A positive finding of excessive noise degradation or decreased synchrony in the cABR would provide biological evidence of an auditory processing disorder.

APD may be associated with other factors related to cognitive or executive function, which may influence the cABR through top-down connections from the cortex to the brainstem.

More work should be done to verify the efficacy of using the cABR when evaluating children with suspected APD.

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