cABR May Improve Hearing Aid Outcomes

By Nina Kraus, PhD, & Samira Anderson, AuD

Every audiologist who has ever dispensed hearing aids knows the frustration of patients who return for follow-ups because of problems with sound quality, performance in noise, or other issues. These challenging experiences have led many to pursue audiology doctorates to understand the neural mechanisms of speech processing that might underlie these issues.

The primary focus of hearing aid fitting for many years has been to provide audibility without sacrificing comfortable loudness levels, but the role of cognitive factors in hearing aid fittings and the constraints imposed by age- and deprivation-induced changes in central auditory processing have been a focus in the past decade. (*Int J Audiol* 2003;42[Suppl 1]:S49.) Real-ear measures enable us to ensure that our patients are receiving appropriate levels of amplification, at least at the tympanic membrane. The effects of amplification, however, on the speech signal once it is transmitted past the tympanic membrane to the inner ear and the rest of the brain remain largely unknown.

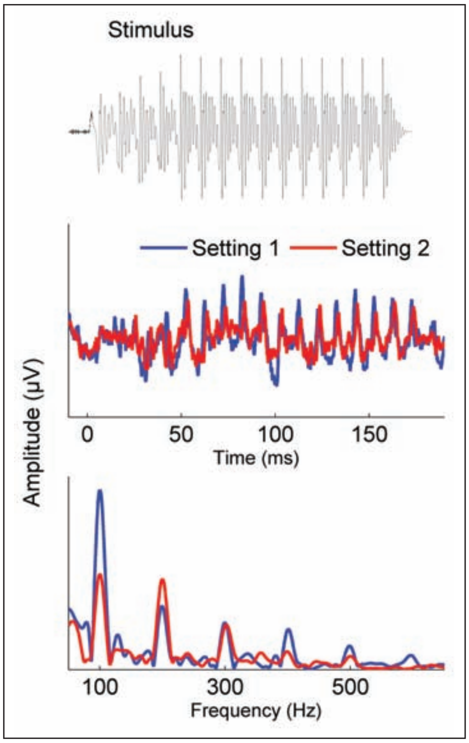


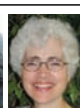
Figure. *The stimulus waveform is displayed at the top. The cABR waveforms (middle) and the response spectra (bottom) are overlaid to demonstrate the difference in responses obtained to different hearing aid settings.*

The auditory brainstem response to complex sounds (cABR) provides an objective means of assessing auditory processing, and its incorporation into hearing aid fittings may help to determine how well amplified speech and other signals are being represented in the central auditory system. The auditory brainstem, specifically the inferior colliculus, is an important site of auditory processing, receiving afferent and efferent input. (*Nat Neurosci* 2002;5[1]:57.) Knowledge of the brainstem's spectral and temporal encoding of amplified sounds may guide the researcher who is interested in the development of improved hearing aid technology and algorithms.

Use of the cABR during hearing aid fittings may confirm its benefit to central auditory processing. An individual with impaired temporal processing, for example, might respond better to slow-acting compression. Evidence shows that individuals with hearing loss have deficits in processing temporal fine structure, a problem exacerbated by aging, and this difficulty may hinder selective listening to speech in noisy backgrounds. (*Int J Audiol* 2010;49[11]:823; *Ear Hear* 2010; 31[6]:755.) Slow-acting versus fast-acting compression might be appropriate for individuals unable to process temporal fine structure. (*Trends Amplif* 2008;12[2]:103.) The cABR would provide a means of assessing an individual's unaided and aided ability to encode the temporal envelope and fine structure in quiet and in background noise.

Cortical-evoked potentials have been used to document auditory system development after initiation of hearing aid amplification or cochlear implantation in infants and young children, but use of the cABR for adult hearing aid fitting has not yet been explored. (*J Commun Disord* 2009;42[4]:272.) We compared sound field cABR recordings in unaided and aided conditions with different hearing aid algorithms in our single-person case study. A noticeable difference was observed in the waveforms' amplitude in these different conditions. A meaningful estimate of speech encoding's robustness can be obtained by performing a cross-correlation between the stimulus and response because the cABR waveform is visually and acoustically similar to its evoking speech waveform. (*Neuroreport* 1995;6[17]:2363.)

We found that one particular hearing aid algorithm produced the highest stimulus-to-response correlation, indicating the best representation of the speech signal's temporal and spectral cues. Whether robust brainstem representation of auditory signals leads to improved patient satisfaction remains to be evaluated. The individual in our case study preferred the setting that yielded the most favorable cABR. (Figure.) Future work will be conducted to determine if the cABR improves hearing aid outcomes, especially in difficult cases.

Dr. Kraus (left) is a professor of auditory neuroscience, investigating the neurobiology underlying speech and music perception and learning-associated brain plasticity, at Northwestern University in Evanston, IL. **Dr. Anderson** (right) was a clinical audiologist for 26 years before entering the doctoral program at Northwestern University in 2007. She will join the faculty at the University of Maryland in January, where she plans to continue her research on the effects of hearing loss and aging on neural processing in older adults.