The Effects of Aging on Auditory Processing

By Nina Kraus, PhD & Samira Anderson, PhD

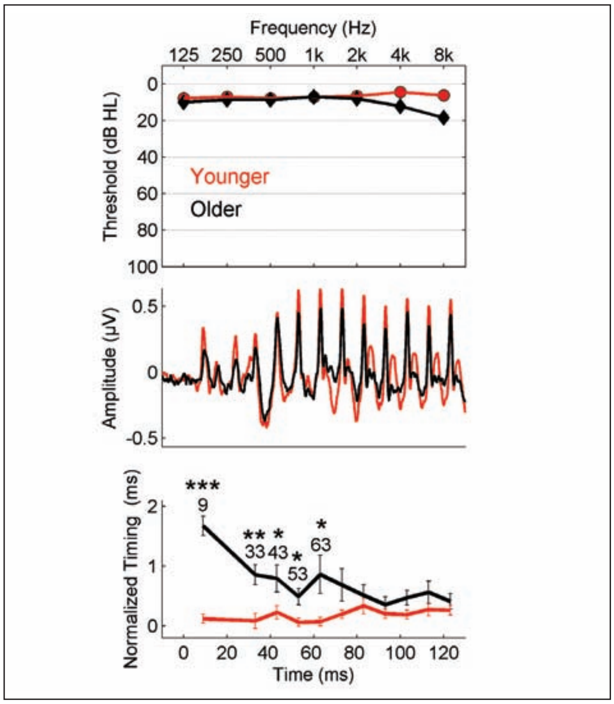
The effects of aging on peripheral hearing function are well known, and age-related hearing loss (presbycusis) is common among those over 60. (*Am J Epidemiol* 1998;148[9]:879.) An audiologist during a typical hearing evaluation considers whether test results conform to expectations for a presbycusis hearing loss, which is a gradually sloping hearing loss in the high frequencies.

What we may fail to consider, however, are the effects of aging on central processing. The American Academy of Audiology Task Force on Central Presbycusis recently published a review of the literature for central presbycusis, concluding that evidence supports the existence of a central presbycusis that arises from a combination of factors involving age- and disease-related issues, including changes in cognitive function. (*J Am Acad Audiol* 2012;[8]:635.)

The task force focused primarily on perceptual studies in their review. Electrophysiological methods provided an objective approach to assessing central auditory biological function in older adults. Age-related timing deficits have been found in cortical speech-evoked responses, mirroring perceptual deficits in the ability to distinguish voice-onset-time differences. (*Clin Neurophysiol* 2003;114[7]:1332.) Pervasive neural slowing with increased age may account for these deficits. We investigated evidence for neural slowing in the auditory brainstem to better understand hearing in noise deficits in older adults.

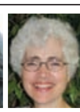
We compared brainstem responses with a speech syllable [da] in younger and older adults who were matched for sex, IQ, and hearing, and found that response amplitudes were smaller and peak latencies were delayed in the older adultsí responses. (*J Neurosci* 2012;32[41]:14156.) The older adultsí responses also had reduced phase locking, decreased response consistency, and greater levels of neural noise. These age-related effects likely arise from factors affecting neural synchrony and the precision of neural speech encoding, including decreased levels of inhibitory neurotransmitters and temporal jitter. (*J Exp Biol* 2008;211[Pt 11]:1781; *Hear Res* 2007; 223[1-2]:114). These responses may also be affected by decreased cognitive function through top-down modulation of brainstem function.

What is the relevance of these findings for the audiologic practice? Older people whose hearing loss symptoms are not reflected in pure-tone or speech audiometry results may be experiencing increased difficulties stemming from central presbycusis. Counseling and management should take into account treatment options beyond providing audibility. A recent study, for example, comparing cochlear implant outcomes in different age groups found that older adults had similar learning curves to young adults when listening to speech in quiet but their learning curves did not maintain the younger adultís rate of improvement when listening to speech in noise, presumably because of central presbycusis or changes in cognitive function. (*Laryngoscope* 2012;122[6]:1361.) These results would indicate that older adults may require more auditory training and the use of assistive listening devices to achieve adequate auditory function in difficult listening environments.



*Audiograms of younger (red) and older (black) participants with matched hearing levels through 2 kHz. (*Adapted from J Neurosci *2012;32[41]:14156.)*

The findings of neural slowing in older adults may also be applicable to hearing aid fittings. It has been suggested that slow-acting compression algorithms are more appropriate for those with cognitive declines and also maybe for those who show evidence of central presbycusis, either through a perceptual test of temporal resolution, such as gap detection, or through delayed or degraded brainstem responses to speech stimuli. (*J Am Acad Audio* 2007;18[7]:604.) We need to remember, when assessing and counseling older adults who report hearing difficulties, that we hear with our brains, not just our ears, and to consider the ramifications of central presbycusis on auditory function in real-world environments.

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.