Better Speech Processing in Smaller Amplitudes

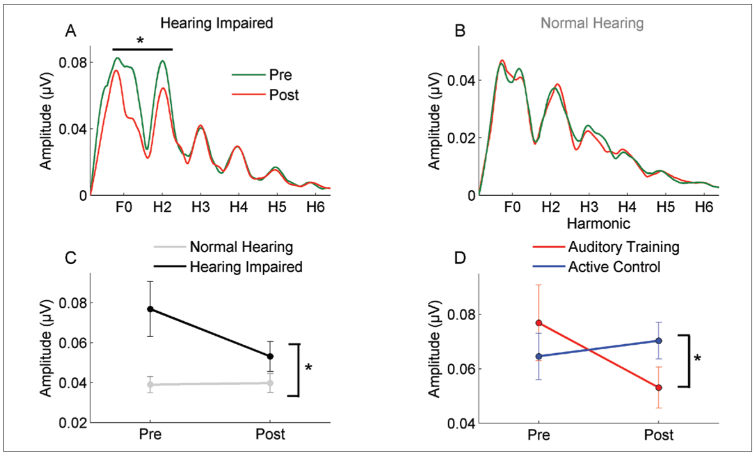
By Nina Kraus, PhD, & Samira Anderson, AuD, PhD

When we think of training, we typically equate improvement with something getting bigger or stronger, like a muscle. We might then expect that auditory training would have similar effects.

In fact, several studies in young adults have found that training increases neural responses to auditory stimuli. For example, after training on discrimination of unfamiliar voice-onset-time contrasts, the mismatch negativity response and the P2 component of the magnetoencephalographic response increase (*J Acoust Soc Am* 1997;102[6]:3762-3773; *BMC Neurosci* 2013;14:151).

There is also evidence that auditory training can enhance responses subcortically.

Judy H. Song and colleagues found greater representation of pitch in speech-evoked brainstem responses after training (*Cereb Cortex* 2012;22[5]:1180-1190). Frequency discrimination training also enhances subcortical representation of pitch (*J Assoc Res Otolaryngol* 2011;12[1]:89-100).



Auditory training reduces representation of the low frequencies in older adults with hearing loss (A) but not in older adults with normal hearing (B). After training, response amplitudes in older adults with hearing loss decrease to levels in line with those of older adults with normal hearing (C). A significant training × test session interaction indicates that changes were seen only in the auditory training group (D). (Adapted from Front Syst Neurosci *2013;7:97.)*

TRAINING IN OLDER ADULTS

As noted in the January Hearing Matters column (*HJ* p. 24), older adults with hearing loss have larger amplitudes in response to the envelope component of the speech stimulus than older adults with normal hearing.

It was suggested that this exaggerated envelope encoding may swamp the details of the temporal fine structure that are important for localization and for hearing in fluctuating noise (*J Acoust Soc Am* 2013;133[5]:3030-3038). Therefore, a training-induced increase in the amplitude of the envelope response may not be beneficial in these patients.

We compared brainstem responses to the speech syllable /da/ presented in babble noise before and after training in older adults with normal hearing and with hearing loss (*Front Syst Neurosci* 2013;7:97).

We used the Posit Science Brain Fitness software package. The training consisted of six modules that combined memory demands with auditory discrimination of adaptively expanding and contracting consonant–vowel transitions in syllables, words, and sentences.

The participants engaged in training one hour per day, five days a week, for eight weeks. An active control group watched educational DVDs and answered questions on the same training schedule.

After training, the auditory training group with hearing loss had lower brainstem amplitudes in response to the envelope, but there was no change in the amplitude of temporal fine structure representation.

No changes were noted in the group with normal hearing or in either hearing group that underwent the active control training. Interestingly, after training, response amplitudes in the auditory training group with hearing loss were reduced to levels similar to those of the group with normal hearing.

Both hearing groups who had auditory training also experienced improvements in speech-in-noise perception (QuickSIN), short-term memory, and attention.

The training required careful attention to the fast-changing consonant–vowel transition. Perhaps the reduction in amplitude was triggered by a top-down modulation of gain to increase the salience of the temporal fine structure.

These results highlight the need to consider the target group when designing training. An important question for the future is whether the neural response to the envelope decreases over time once an individual starts wearing hearing aids.

This work was supported by the National Institutes of Health (grants T32 DC009399-01A10 and R01 DC10016) and the Knowles Hearing Center.

Dr. Kraus, left, is professor of auditory neuroscience at Northwestern University, investigating the neurobiology underlying speech and music perception and learning-associated brain plasticity. **Dr. Anderson** is an alumna of Dr. Kraus's Auditory Neuroscience Laboratory and assistant professor in the University of Maryland Department of Hearing & Speech Sciences, where she is studying the effects of hearing loss and aging on neural processing in older adults.