Bilingualism Enhances Neural Speech Encoding

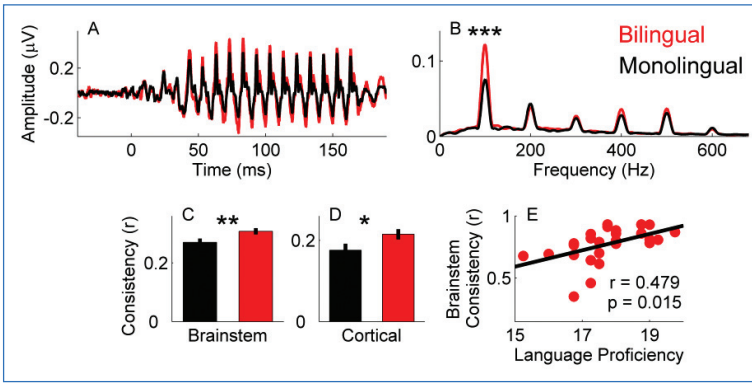
By Nina Kraus, PhD, & Samira Anderson, AuD, PhD

Most Americans are monolingual, but, with increased population diversity and international travel, more people are interested in the impact of bilingualism.

Since the bilingual brain develops the facility to switch from one language to another, executive function abilities that engage attention and inhibit irrelevant information are present to a greater degree in these speakers (*Cerebrum* 2012:13).

Babies raised in bilingual homes more easily adapt to stimuli changes in an auditory learning task than babies raised in monolingual homes (*Proc Natl Acad Sci U S A* 2009;106[16]:6556-6560).

Bilingualism also seems to have a protective effect against age-related cognitive decline. In a group of patients with probable Alzheimer's disease, bilingual patients were diagnosed 4.3 years later than monolingual patients (*Neurology* 2010;75[19]:1726-1729).



Adolescents raised in bilingual households had stronger subcortical responses to a speech syllable in the time (A) and frequency (B) domains, as well as greater response consistency for brainstem (C) and cortical (D) recordings. Brainstem response consistency was positively related to language proficiency only in the bilingual group (E). *p < 0.05, **p < 0.01, ***p < 0.001. (Adapted from *Proc Natl Acad Sci U S A* 2012;109[20]:7877-7881 and *Brain Lang* 2014;128[1]:34-40.)

In a previous issue, we discussed the benefits of playing a musical instrument for long-term training (*Hear Res* 2014;308:109-121). The use of multiple languages may also be viewed this way.

KEEPING CONSISTENT

Jennifer Krizman and colleagues evaluated the effects of bilingualism on neural speech encoding in monolingual and bilingual adolescents who were matched based on IQ and socioeconomic status.

In the first study, the researchers evaluated auditory neural responses to the syllable /da/ presented in quiet and in six-talker babble noise (*Proc Natl Acad Sci U S A* 2012;109[20]:7877-7881).

Bilingual adolescents had stronger subcortical encoding of speech in noise than monolingual adolescents, with larger response amplitudes and greater representation of the fundamental frequency. These effects were seen in both the quiet and noise conditions, but the differences were more pronounced in noise.

Sustained selective attention was positively related to the amplitude of the fundamental frequency in the noise condition, but only in bilingual participants.

In a follow-up experiment, Krizman and colleagues found higher consistency in brainstem and cortical responses among bilingual compared with monolingual adolescents (*Brain Lang* 2014;128[1]:34-40).

Furthermore, brainstem response consistency was positively related to language proficiency and auditory attentional control, suggesting that the efferent connections from the prefrontal cortex to the brainstem are strengthened by activation and suppression of different languages in the bilingual brain.

However, we know that nonnative English speakers have poorer performance on speech-in-noise tests than native English speakers, as Catherine L. Rogers and colleagues noted (*Appl Psycholinguist* 2006;27[3]:465-485).

The authors suggested that bilingual speakers need greater attentional resources to select a target word or phoneme because of the presence of competing languages, at the cost of the resources needed to accurately perceive the speech signal in noise. Similarly, in older adults, speech-in-noise performance declines relative to that of younger adults when cognitive load increases (*J Acoust Soc Am* 1995;97[1]:593-608).

Aging and hearing loss may have a greater impact on speech-in-noise performance in bilingual patients.

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.