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Bilingualism fine-tunes hearing, enhances attention

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A Northwestern University study that will be published in the *Proceedings of the National Academy of Sciences* (*PNAS*) provides the first biological evidence that bilinguals' rich experience with language in essence "fine-tunes" their auditory nervous system and helps them juggle linguistic input in ways that enhance attention and working memory.

Northwestern bilingualism expert Viorica Marian teamed up with auditory neuroscientist Nina Kraus to investigate how bilingualism affects the brain. In particular, they looked at subcortical auditory regions that are bathed with input from cognitive brain areas. In extensive research, Kraus has already shown that lifelong music training enhances language processing, and an examination of subcortical auditory regions helped to tell that tale.

"For our first collaborative study, we asked if bilingualism could also promote experience-dependent changes in the fundamental encoding of sound in the brainstem -- an evolutionarily ancient part of the brain," said Marian, professor of communication sciences in Northwestern's School of Communication. The answer, according to their study, is a resounding yes.

The researchers found that the experience of bilingualism changes how the nervous system responds to sound. "People do crossword puzzles and other activities to keep their minds sharp," Marian said. "But the advantages we've discovered in dual language speakers come automatically simply from knowing and using two languages. It seems

that the benefits of bilingualism are particularly powerful and broad, and include attention, inhibition and encoding of sound."

Co-authored by Kraus, Marian and researchers Jennifer Krizman, Anthony Shook and Erika Skoe, "Bilingualism and the Brain: Subcortical Indices of Enhanced Executive Function" underscores the pervasive impact of bilingualism on brain development. The article will appear in the April 30 issue of *PNAS*.

"Bilingualism serves as enrichment for the brain and has real consequences when it comes to executive function, specifically attention and working memory," said Kraus, Hugh Knowles Professor at Northwestern. In future studies, she and Marian will investigate whether these results can be achieved by learning a language later in life.

In the study, the researchers recorded the brainstem responses to complex sounds (cABR) in 23 bilingual English-and-Spanish-speaking teenagers and 25 English-only-speaking teens as they heard speech sounds in two conditions.

Under a quiet condition, the groups responded similarly. But against a backdrop of background noise, the bilingual brains were significantly better at encoding the fundamental frequency of speech sounds known to underlie pitch perception and grouping of auditory objects. This enhancement was linked with advantages in auditory attention.

"Through experience-related tuning of attention, the bilingual auditory system becomes highly efficient in automatically processing sound," Kraus explained.

"Bilinguals are natural jugglers," said Marian. "The bilingual juggles linguistic input and, it appears, automatically pays greater attention to relevant versus irrelevant sounds. Rather than promoting linguistic

confusion, bilingualism promotes improved 'inhibitory control,' or the ability to pick out relevant speech sounds and ignore others."

The study provides biological evidence for system-wide neural plasticity in auditory experts that facilitates a tight coupling of sensory and cognitive functions. "The bilingual's enhanced experience with sound results in an auditory system that is highly efficient, flexible and focused in its automatic sound processing, especially in challenging or novel listening conditions," Kraus added.

Provided by Northwestern University