

Music to My Ears: Enhanced Speech Perception Through Musical Experience

By Dylan J. Sheridan and Lisa L. Cunningham

The perception of emotion in speech is vital to communication and social interactions.

This perception relies on our ability to maintain and understand the paralinguistic (nonverbal) elements of speech. Diseases that disrupt the perception of emotion in speech can result in social isolation. Autism spectrum disorders, for example, are characterized by such communication problems. In addition, some individuals with auditory processing disorder (APD) are unable to perceive verbal and nonverbal aspects of speech and therefore have difficulty communicating in noisy environments (Moore, 2007). Scientists are examining the mechanisms underlying the perception of paralinguistic speech cues with the goal of developing therapies aimed at improving communication for persons with these disabilities.

Musical training is one possible therapeutic approach to help the brain better perceive certain sound characteristics. The auditory pathway has multiple levels of neuronal organization in order to filter, classify, and comprehend sounds produced by speech and music. This

highly organized pattern of neurons allows the brain to identify the characteristics of a sound stimulus, including subtle differences in pitch (frequency), timbre (quality), timing, and loudness (intensity). The brain's finely tuned ability to accurately relay and interpret changes in paralinguistic elements of speech is the essence of perceiving vocalized emotion (Strait et al, 2009). It has long been known that genetic factors play an important role during development of the auditory system. However, only recently have scientists begun to unravel the complexities of how experience can change the functional capacities of the auditory system.

The brains of professional musicians have larger volumes of grey matter within the auditory, sensory, and motor regions of the cortex, compared to nonmusicians (Gaser and Schlaug, 2003). In addition, cortical modifications can be induced by both long-term and short-term musical training (Pantev et al, 2003; Trainor et al, 2003), providing further evidence that musical experience can alter the cortex. Recent studies by Nina Kraus and members of her laboratory


at Northwestern University indicate that musical experience can also alter subcortical brain regions. Using a stimulus designed to provoke strong negative emotions (an infant's unhappy cry), they examined auditory brainstem responses (ABR) in musicians and nonmusicians. This stimulus consisted of both periodic and complex portions. The ABRs of musicians were different from those of nonmusicians in response to both the complex and less-complex (periodic) portions of the stimulus. Relative to nonmusicians, musicians showed enhanced response amplitudes to the complex portions of the stimulus and reduced amplitudes in response to the periodic portions of the stimulus. Additionally, subjects that began their musical training before the age of seven showed enhanced frequency tracking and were better able to perceive pitch and timbre features of the stimulus (Strait et al, 2009). These data provide biological evidence that musical training enhances the brain's ability to discern emotional aspects of speech (Strait et al, 2009).

In a series of studies, these scientists have shown that musical

training enhances subcortical sensory infrastructure and imparts advantages to the processing of speech (Wong et al, 2007; Musacchia et al, 2008; Kraus et al, 2009; Strait et al, 2009). Their most recent finding (Parbery-Clark et al, 2009) demonstrates that musicians have enhanced processing of speech in background noise.

The enhancements in the musicians' responses to the complexity of the stimulus could be due to cortical influences on subcortical regions of the brain (reviewed in Tzounopoulos and Kraus, 2009). Both music and language are primarily cortical functions, and the cortex can influence subcortical regions via extensive descending neuronal fibers that synapse on multiple subcortical targets. These "top-down" modifications (i.e., cortical influences on subcortical regions) are likely to be involved in shaping the enhanced responses of musicians to various aspects of vocal communication (Wong et al, 2007; Musacchia et al, 2008; Kraus et al, 2009; Strait et al, 2009). Additional evidence to support mechanisms of top-down modulation has been shown in both animals and humans (Suga et al, 2000; Perrot et al, 2006).

Basic understanding of the processing the paralinguistic elements of verbal communication will help us understand the mechanisms underlying diseases that disrupt these critical communication functions. In addition, insight into the ways in which musical experience can enhance the processing of both linguistic and paralinguistic cues

paves the way for development of musical training therapies aimed at improving communication for persons with APD and autism spectrum disorders. 

Dylan J. Sheridan, BS, is a second-year medical student at the Medical University of South Carolina and Lisa L. Cunningham, PhD, is an assistant professor with the Department of Pathology and Laboratory Medicine at the Medical University of South Carolina.

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