Community-Based Training Shows Objective Evidence of Efficacy

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

Auditory training works. Behavioral and neurophysiological studies have demonstrated training-related benefits in a variety of populations, including children with hearing loss or auditory-based learning impairments, young adults learning non-native lexical contrasts, and older adults with or without hearing loss.

Most of the training in these studies was done with rigorous control under the direction of research personnel. To ensure that training is implemented outside the lab, however, it is important to establish efficacy in community settings.

Music is an effective medium for improving auditory skills, with demonstrated benefits for cognition, speech perception, and other areas (*Hear Res* 2014;308:109-121).

Music training enhances the robustness of neural encoding of speech stimuli, making responses more resistant to the degradative effects of noise. These enhanced neural responses facilitate the establishment of strong sound-to-meaning connections, which can form the basis for improvement in academic performance and auditory-based communication skills.

Therefore, community-based music programs may serve as models for real-world auditory learning.

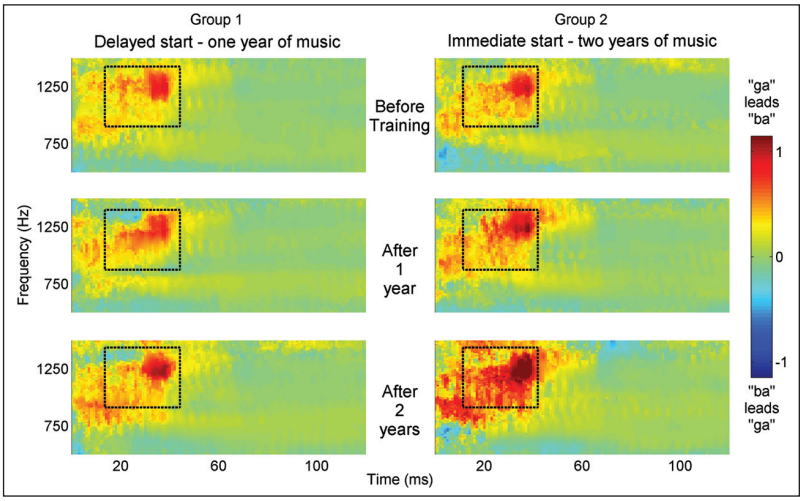

Figure 1. After two years of music training, Group 2 had increased brainstem differentiation, as indicated by the greater concentration of red color, in the region corresponding to the formant transition of the syllables during which they are maximally different. No significant changes were noted after one year of training in Group 1 or 2. (Republished with permission of the Society for Neuroscience from: Kraus N, Slater J, Thompson EC, et al. Music enrichment programs improve the neural encoding of speech in at-risk children. *J Neurosci* 2014;34[36]:11913-11918.)

ELEMENTARY STUDENTS IN L.A.

Over the last few years, the Kraus Lab collaborated with two community-based music programs–one with elementary school students, and another with high school students.

The elementary school students participated in the Harmony Project, an award-winning program aimed at providing music training to elementary students in Los Angeles's low-income communities (harmony-project.org).

Dr. Kraus, left, is a 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.

The students receive musical instruments to take home and use as their own, and they participate in music instruction and play in a music ensemble after school, starting in elementary school and continuing through high school.

Since 2008, 93 percent of Harmony Project seniors have gone on to college despite dropout rates of 50 percent or more in their neighborhoods. The Kraus Lab was asked to investigate what was going on in the children's brains to engender these successful academic outcomes.

Members of the Kraus Lab flew to Los Angeles and provided on-site testing during three consecutive summers. They assessed two groups of students age 6 to 9 drawn from the Harmony Project's waiting list (*J Neurosci* 2014;34[36]:11913-11918).

By random assignment, the first group deferred participation in music training for one year (Group 1), and the second group began music training immediately (Group 2). The music training starts with six months of musicianship classes, two hours weekly, and then moves to group instruction for four or more hours per week on strings, woodwinds, or brass winds.

In both groups, brainstem responses to the speech syllables /ba/ and /ga/ were recorded prior to the beginning of

training and after years one and two. Differentiation of these consonants was measured by neural timing (phase) differences.

The phaseogram results indicated increased brainstem differentiation, or more precise encoding, of the two syllables after two years of training in Group 2 (figure 1), but there were no significant differences after one year in either group.

HIGH SCHOOL STUDENTS IN CHICAGO

The second community-based program is based in Chicago Public Schools (*Front Psychol* 2013;4:855).

High school students participating in either music or physical training were seen for behavioral and neurophysiological testing at yearly intervals, starting the summer before their freshman year in high school and continuing until the summer after graduation.

The music curriculum includes band or choral practice, with practice in sight reading and playing/singing technique. The physical training curriculum aims to develop leadership skills and strengthen character through classroom instruction and fitness training.

Brainstem responses were recorded to the speech syllable /da/ presented in multi-talker babble. Neural timing was assessed objectively by calculating the time lag between the stimulus and the response needed to achieve a maximum stimulus-to-response correlation, and by measuring phase differences between the responses obtained at pre- and post-training sessions.

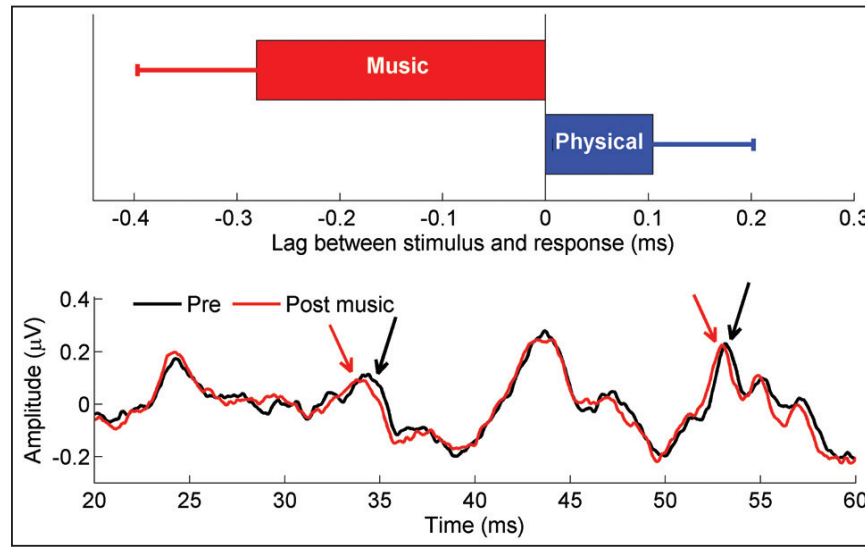

Figure 2. Top: The change in stimulus-to-response lag between pre- and post-music-training sessions indicates a negative shift in time that's consistent with earlier response timing after training. Bottom: This earlier neural timing in the post session can also be seen in the waveform peaks of an example individual who participated in music training. (Adapted from *Front Psychol* 2013;4:855.)

The adolescents who participated in music training had faster neural timing after two years, and neural responses were more stable.

The adolescents who participated in music training had faster neural timing after two years of music training, and neural responses were more stable (less disrupted by noise). No changes were noted in the physical training group (figure 2).

REAL-WORLD AUDITORY TRAINING

These studies demonstrate several important principles:

- Music training is an effective strategy for improving neural speech encoding.
- The effects of music training in a community-based program take time to develop. Two years of training were required to see effects in each of the studies.
- These changes can be documented in less-than-ideal environments. Testing for the Harmony Project was conducted in quiet classrooms, not in an electrically shielded booth, which is typically used in research studies.

It is important to inform our understanding of the impact of auditory training in real-world settings, such as schools and clinics, and in terms of real-world outcomes, such as academic success and everyday communication skills.