The NAMM Foundation provides funding for projects such as the work below by neurobiologist Nina Kraus, which offers insight into how musical experience affects brain function across the lifespan.

The Biological Benefits of Music Education

The Auditory Neuroscience Laboratory at Northwestern University pursues cutting-edge scientific research examining the biological basis of human communication and learning. Our research with auditory experts, such as musicians, has helped to advance understanding of how the brain is changed by musical experience across the lifespan. Through collaborations with schools and music educators, our extensive research program combines lab-based experiments with real-world studies to provide unique insight into the biological benefits of music education.

An important goal of our research is to understand how the enrichment provided by musical engagement may help counteract the negative biological effects of poverty. As we continue to build upon the successes of our collaborations with schools and community-based programs, we are able to provide critical scientific insight into the significant positive effects music education has on study participants in real-world settings. This research program provides essential data for educators and policymakers interested in understanding how music education shapes brain development. Our next, and perhaps most important job, is to communicate our findings to the broader public through frequent updates in scientific literature and user-friendly overviews on our website. This, in addition to performing continued outreach at schools and with community organizations. Due to the importance of our work, we have received extensive coverage from media outlets including *The New York Times*, *The Atlantic*, BBC and NPR.

Neuroeducation

A cornerstone of our research program are our neuroeducational studies. The goal of our neuroeducational studies is to perform rigorous scientific assessment of real-world music education programs.

Highlights:

- The scope and success of our projects is unprecedented in this field of research, because large-scale, controlled longitudinal studies present significant logistical challenges.
- Collaborations with Chicago Public Schools and the Los Angeles-based Harmony Project allow us to assess the impact of music education on low-income populations. Working with populations that may not otherwise have access to music education provides valuable information for where the enrichment provided by musical engagement may help to offset the biological impact of poverty [1].

- In both adolescents and elementary school-age children we track the gradual emergence of neural processing enhancements with musical training [2, 3,] consistent with more precise neural encoding of sound in highly trained musicians [4].
- Our research discovered that elementary school children participating in the Harmony Project also showed stronger rhythm skills [5] and were better able to hear verbal cues in a noisy background [6].

Language and listening skills

The goal of our language research is to understand how musical experience strengthens auditory skills that are important for language development and learning.

Highlights:

- Everyday listening skills are stronger in musically-trained children than in those without music training [4, 7]. Significantly, listening skills are closely tied to the ability to: perceive speech in a noisy background, pay attention, and keep sounds in memory.
- Our research reveals that musical experience strengthens many of the same aspects of brain function that are impaired in individuals with language and learning difficulties [8], such as the neural timing precision which allows differentiation between speech syllables.

Rhythm

The goal of our research with rhythm is to examine links between rhythm and language abilities.

Highlights:

- Our research reveals strong connections between rhythm skills and pre-reading abilities in toddlers [12]. We track the development of these skills in individual children as part of an extensive longitudinal study.
- Adolescent-centered studies show that even very basic rhythm abilities, such as tapping to a beat, relate with reading skills [9], and we have provided initial evidence for how both abilities may rely on common underlying neural mechanisms of sound processing [10, 11].
- Rhythm is a fast-growing area of research in our lab, with experimental methods of assessment now in place used to investigate specific aspects of rhythm processing across our research populations.

Music across the lifespan

Our research studies include participants of all ages—from infants to older adults. The goal of our lifespan research is to assess the impact of musical experience on brain and behavior across the lifespan.

Highlights:

- We have found that musical expertise is associated with distinctive enhancements in how the nervous system encodes sound (such as stronger representation of harmonic information and greater resilience to noise) that emerge with musical training, even in early childhood [4, 13-15].
- Our research shows that cognitive and neural benefits of musical experience continue throughout the lifespan, and counteract some of the negative effects of aging, such as memory and hearing difficulties in older adults [16-20.]
- Studies conducted by our team show that even a few years of musical training early in life improve how the brain processes sound. We have also learned that the benefits of early exposure to music education last well into adulthood, years after the training has ceased [21, 22].

Nina Kraus, Ph.D.

Auditory Neuroscience Lab

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Mission

The Auditory Neuroscience Laboratory studies the neurobiology of auditory learning and memory, with the goal of harnessing neuroplasticity to improve human communication. We investigate the neurobiology of auditory learning and memory across multiple timescales and populations, including short-term auditory training, the biological imprint of past learning, and lifelong language and music experience.

Projects

The Auditory Neuroscience Laboratory provides critical scientific insight into the significant positive biological effects music education has on study participants across the lifespan. Through collaboration with schools and music educators, this extensive research program combines lab-based experiments and real-world settings to understand how the enrichment provided by musical engagement may help counteract the negative biological effects of poverty. Dr. Kraus's program provides essential data for policymakers, educators and parents interested in how music education shapes brain development.

Impact

We publish in major impact journals and are exceptionally productive, having published over 300 peer-reviewed articles—over 100 in the past 5 years alone.

Trainees

My lab has a long history of attracting exceptional doctoral students (28 in my career) and post-doctoral trainees (15 in my career), who at the conclusion of their training move on to successful careers as professors, clinicians, scientists, engineers and editors.

Outreach

We are committed to translating our findings to the clinic, classroom, community, and industry.

Our synergistic translational activities include:

- Friendly overview slideshows on our website updated with new findings daily
- Science outreach to local schools
- A column in *Hearing Journal*, featuring our latest research to keep clinicians informed
- A quarterly newsletter informing participants and families of the lab's recent activities

Awards

National Institutes of Health
National Science Foundation
National Association of Music Merchants
GRAMMY Foundation
Knowles Hearing Center

website: www.brainvolts.northwestern.edu • Facebook: Auditory Neuroscience Laboratory
Twitter: @brainvolts • e-mail: nkraus@northwestern.edu

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