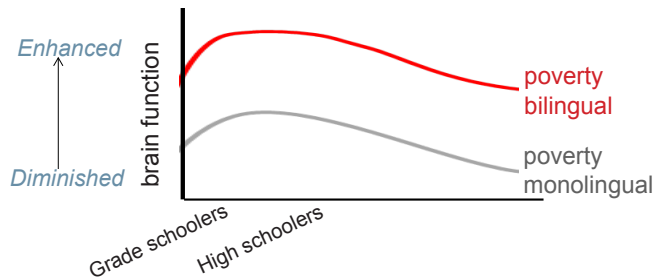


## The changing, learning brain

The brain is capable of change, and making music drives positive changes. Due to the overlap of brain circuits dedicated to speech and music, and the distributed network of cognitive, sensorimotor, and reward circuits engaged during music making, music training is a particularly potent driver of brain plasticity that influences the biological processes important for listening, language, and learning.

Previous research has shown that poverty negatively influences brain function, resulting in less efficient, less consistent, and “noisier” sound processing. Music training can help erase this poverty signature. It is equally promising that our lab similarly found that bilingualism appears to counter poverty’s impact<sup>9</sup>.



## Advocacy Summary

Cost-effective school- and community-based programs offer the potential to stimulate biological changes in neural processes important for academic success. Our hope is that our findings catalyze educators and legislators responsible for policy making to promote the birth and growth of music training programs in mainstream education.

### References:

- <sup>1</sup> Kraus N, Thompson EC, Krizman J, Cook K, White-Schwoch T, LaBella CR (2016) Auditory biological marker of concussion in children. *Nature: Scientific Reports*. 6: 39009.
- <sup>2</sup> Skoe E, Krizman J, Anderson S, Kraus N (2015) Stability and plasticity of auditory brainstem function across the lifespan. *Cerebral Cortex*. 25(6): 1415-1426.
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- <sup>4</sup> Tierney A, Krizman J, Kraus N (2015) Music training alters the course of adolescent auditory development. *Proceedings of the National Academy of Sciences*. 112(32): 10062-10067.
- <sup>5</sup> Kraus N, Slater J, Thompson EC, Hornickel J, Strait D, Nicol T, White-Schwoch T (2014) Music enrichment programs improve the neural encoding of speech in at-risk children. *Journal of Neuroscience*. 34(36): 11913-11918.
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- <sup>7</sup> Tierney A, Krizman J, Skoe E, Johnston K, Kraus N (2013) High school music classes enhance the neural processing of speech. *Frontiers in Educational Psychology*. 4(855).
- <sup>8</sup> Slater J, Skoe E, Strait D, O'Connell S, Thompson EC, Kraus N (2015) Music training improves speech-in-noise perception: longitudinal evidence from a community-based music program. *Behavioural Brain Research*. 291: 244-252.
- <sup>9</sup> Krizman J, Skoe E, Kraus N (2016) Bilingual enhancements have no socioeconomic boundaries. *Developmental Science*. 19(6): 881-891.
- <sup>10</sup> Kraus N, White-Schwoch T (2017) Neurobiology of everyday communication: what have we learned from music? *The Neuroscientist*. 23(3): 287-298.

# Neuroeducation Advocacy

What research is telling us

Impact of poverty, music, bilingualism, and concussion on the brain



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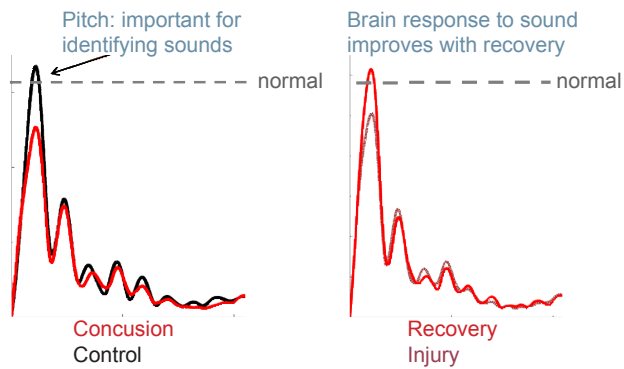
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# What *disrupts* our ability to make sense of sound?

## Concussion

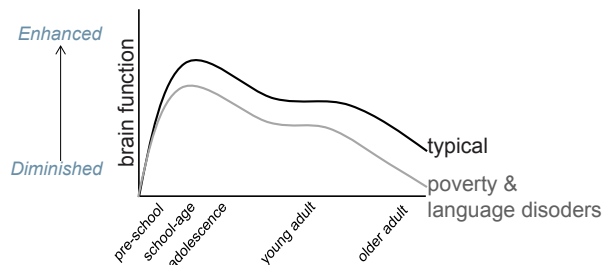
Making sense of sound is one of the hardest jobs the brain has to do, which is why this fast, delicate, and intricate ability can be disrupted by a head injury.

Using the frequency-following response, we can measure sound processing in the brain. Our research shows that children with a concussion have weaker brain responses to sound. But such response improves as children recover<sup>1</sup>.



## Poverty & Language Disorders

Poverty-induced linguistic deprivation and developmental language disorders can diminish sound processing in the brain<sup>2,3,9</sup>. Our research tells us that brain functions important for classroom learning are often diminished in at-risk children.



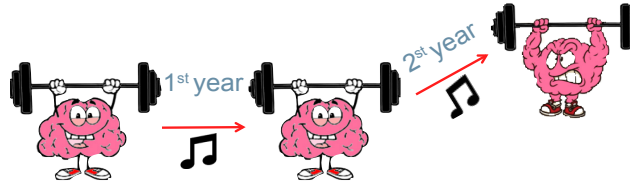
# Music can boost sound and language processing in the brain

Making music changes the brain, and these changes impacts listening skills, learning, and cognition. Historically, research has focused on children enrolled in private lessons beginning at a young age. Through multiyear partnerships with inner-city schools and community-based programs serving disadvantaged grade schoolers and high schoolers, the Kraus Lab tells a new and promising story.

## Community music program for grade schoolers

From our partnership with Harmony Project, a community mentorship foundation that provides free music instruction to gradeschoolers from Los Angeles gang-reduction zones, we learned<sup>5-6,8, 10</sup>:

- **Music training takes time to change the brain:** after two years—but not one—music training enhanced their brains' processing of speech
- **More active = greater improvements:** those who played an instrument improved more than those who took music appreciation classes
- **Music engagement buffers declines in literacy performance** observed in socioeconomically impoverished students
- **Music training improves the ability to understand speech in noisy backgrounds**



## In-school music training for high schoolers

From our partnership with the Chicago Public Schools, we found that<sup>4,7</sup>:

- Starting music lessons **as late as high school** still produced enriching neural effects
- **It takes two years for the enhancement to emerge:** when compared to another program with intense discipline and time investment (ROTC), music students' brain responses were less compromised by background noise.
- **Further improvements were seen after a third year of training:** music students' brain responses matured faster and showed enhanced processing of sound details

