Using Music to Close the Academic Gap

New studies on the cognitive advantages of learning instruments at early ages

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Several times a week, a group of at-risk youth in Los Angeles reports to makeshift music rooms at Alexandria Elementary School near Koreatown for lessons in violin or cello or bass—and to Saturday ensemble programs where they learn to play with bands and orchestras. As the students study their instruments, researchers study the students' brains.

The children, who devote at least five hours per week to their music, are participants in the award-winning non-profit Harmony Project, which provides free instruments and instruction to kids in underserved areas of the city if they promise to stay in school. The scientists, who hail from Northwestern University's Auditory Neuroscience Laboratory, travel from Evanston, Illinois to a satellite lab in Hollywood for a few weeks each year to examine the impact of the music lessons on the children's language and cognitive skills. What they are finding, according to Dr. Nina Kraus, a professor and neuroscientist at Northwestern and lead researcher of the study, is that music instruction not only improves children's communication skills, attention, and memory, but that it may even close the academic gap between rich and poor students. Kraus reported these results in a National Endowment of the Arts-sponsored webinarin July.

When Plato said that music gives "wings to the mind," he might have been onto something. Recent studies increasingly point to the power of music to shape the brain and boost its functioning. But despite a flurry of research documenting the positive effects of music lessons on the brain, there have been few controlled, longitudinal studies like Kraus's that follow kids year after year and examine music's impact on brain structure and function as it's happening. Instead, most of the studies to date have compared the brains of musicians and non-musicians —or of students who have studied instruments to those who have not—and inferred that brain enhancements in music-makers stem from music training

Kraus's study is part of a new wave of longer-term, forward-looking studies honing in on the neurological impact of school and community-based music training—as opposed to private music lessons, which, according to Kraus, have been the basis of most past studies—particularly on lower-income students who have not previously had access to music education, so study subjects begin on a level playing field. Kraus and her colleagues in Los Angeles will spend the next few years gauging not only how group music instruction affects the way the brain processes sound, but also how it influences classroom and language skills among the elementary school kids enrolled in the Harmony project. Kraus is also evaluating the impact of public school-based music instruction on adolescent brain development in a multi-year study focusing on inner-city high school students in Chicago.

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Meanwhile, another five-year study at the University of Southern California Brain and Creativity Institute is tracking cognitive, emotional, and social development in at-risk elementary school children in the gang-riddled Rampart District of Los Angeles who receive high-intensity music training through the Youth Orchestra Los Angeles program.

And in yet another ongoing five-year study, neuroscientists at the University of California, San Diego are watching to see how intense music ensemble training affects the brain development of children in San Diego's under-served Chula Vista school district, specifically by looking at how it influences connections in the brain. "We clearly believe that if someone becomes better at language perception, something in the brain has changed," says John Iversen, Ph.D., a cognitive neuroscientist at UCSD and lead

researcher of the SIMPHONY (Studying the Influence Music Practice has On Neurodevelopment in Youth) project. “By tracking the same kids for a series of years, we can watch the whole process unfold.”

Though these studies are far from over, researchers, as well as the parents and teachers of the study subjects, are already noticing a change in the kids who are studying music. Preliminary results suggest that not only does school and community-based music instruction indeed have an impact on brain functioning, but that it could possibly make a significant difference in the academic trajectory of lower-income kids.

Unfortunately, these are the kids who typically have less access to quality music education programs. Though a 2012 U.S. Department of Education report found that some degree of music education was offered in the majority of public schools—94 percent of elementary schools and 91 percent of secondary schools—it also revealed an alarming disparity between the availability of music programs in high-poverty and low-poverty schools. The new crop of controlled, multi-year studies promises to further scientists’ understanding of how music training affects the brain, and in so doing, perhaps provide an impetus for social change.

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Much fanfare followed studies in the 1990’s suggesting that exposure to classical music makes the brain work better, improving spatial reasoning as well as concentration. Not only did retailers capitalize on these findings with classical music CDs and videos designed to make babies smarter, but the governor of Georgia at the time, Zell Miller, cited the so-called “Mozart Effect” as his justification for including a $105,000 item in his 1998 state budget to provide a classical music CD to every infant born in Georgia. While most scientists agree that these initial findings were overplayed (and temporary), subsequent studies have shown that active music training has an even more profound—and longer lasting—effect than just being exposed to music.

“Not only does music instruction improve communication skills and create a brain and nervous system that is more attuned to sound, which is important for both music and language," says Kraus, “but music can fundamentally alter the nervous system to create better learners.” What's more, adds Kraus, is that early music experience will have a positive effect on the adult brain whether you continue it or not. In fact, a study by Kraus published last year by the *Journal of Neuroscience*, found that childhood music lessons helped sharpen the brain’s response to sound well into adulthood—even when adults no longer played an

instrument.

Thanks to advances in brain imaging, research into music's effects on the brain has exploded in the past two decades. According to Dr. Aniruddh Patel, associate professor of psychology at Tufts University and a co-investigator with the SIMPHONY study, new neuroimaging tools give scientists an unprecedented window into the brain. And while there is evidence that listening to music has short-term effects on brain physiology and emotion, making music appears to have lasting effects on both brain structure and brain function.

Playing a piece of music involves the auditory, visual, motor and emotional centers of the brain. In fact, according to Dr. Norman Weinberger, research professor of neurobiology and behavior at the University of California, Irvine, brain scans reveal that there is more activity in the brain during a musical performance than there is during most other activities.

Not only does music-making activate many different regions of the brain, but it can actually help to shape the brain itself. "We now know the brain is an organ that changes with experience," Patel says, "and music has an impact on brain structure." That impact appears to be strongest when music training begins in early childhood, when the brain is developing the most rapidly and multiple new connections are being formed. According to Patel, children's brains show evidence of faster development when they are learning to play an instrument. And studies comparing the brains of adult musicians and non-musicians find the most pronounced enhancements in brain structure in those who began their music training early in childhood. Musicians' brains have increased grey matter, which is involved in processing, as well as increased white matter, which is comprised of the connective fibers that link disparate parts of the brain. Several studies have also found that the musician's brain tends to have a larger corpus callosum, which plays an important role in the communication between the left and right sides of the brain.

"The fact that music engages so much in the brain—including regions we think of as important for language, memory, motor control, executive function and emotion—raises the question of how it interacts with these other activities," says Patel. It's not surprising, Patel says, to find that violinists, who make intricate movements with the fingers on their left hand, have enhanced fine motor function and corresponding changes in the regions of the brain that govern left-handed finger control. What's more surprising is that music training actually enhances the way the brain processes language.

By connecting research subjects via scalp electrodes to machines that record the way their brains respond to sound, Kraus and her colleagues at Northwestern's Auditory Neuroscience Lab measure how the brain encodes pitch, timing, and timbre, all three "key ingredients of music *and* speech," according to Kraus. Musicians process both sound and speech more accurately and efficiently. "Not only are they better at encoding what I said, but they are better at interpreting how I mean it," says Kraus "If my pitch goes up, I'm asking a question, if it goes down, I'm making an emphatic statement, and all kinds of emotion is carried by changes in pitch."

Timing and timbre are important in distinguishing between different consonants in speech, like bill vs. pill, or cat vs. bat, something that a child must be able to do in order to read successfully. In fact, Kraus and other researchers have found that children who have better rhythm tend to be better readers as well. And one of the most important cognitive functions strengthened bymusic is auditory working memory, says Kraus—you have to be able to remember the words you just read to understand what comes next, just as a musician has to remember a note that has just been played to tune an instrument or to improvise.

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Musicians are also better able to hear speech amidst other noise, a useful skill for children who are trying to attend to what a teacher is saying in a noisy classroom. "If you present speech in an environment with lots of background noise, the musician's brain is less affected by the addition of the noise," Kraus says. Interestingly, even adult musicians with age-related hearing loss can detect speech in noise more accurately than a non-musician without hearing loss, because their brains are more adept at processing sound.

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Early testing of subjects in the Harmony Project study found improvement in the students' ability to hear speech in noise after just one year of music training—an effect that was not noted in the control group, which consists of equally motivated students on waitlists to get into music classes. Even more striking is that second grade Harmony project participants in Kraus's study made grade-appropriate improvements in their ability to read during their first year of music making while matched controls attending the same schools did not. In fact, those who had not studied music

showed a decline in reading skills between second and third grade, following a national trend in which the education gap between rich and poor students widens over the first few years of schooling. “Existing research indicates that kids from poor homes are not learning to read in the first four years of school – while kids from middle-class and affluent homes are,” says Dr. Margaret Martin, founder of the Harmony Project. “Given the importance of reading in achieving an education, this finding is stunning.”

Scientific data in the SIMPHONY study, which recently completed its first year, is so far limited to baseline assessments of rhythmic ability and brain structure among participants, though Iversen, who presented early results at a Society for Music Perception and Cognition conference this summer, says researchers have noted a relationship between differences in students’ rhythmic ability and differences in their brain structure. But San Diego Youth Symphony’sCommunity Opus program, which provides free after-school, on-site string instrument instruction to students involved in the SIMPHONY study is three years old, and Chula Vista school district officials have been so impressed with how involvement with music is benefitting their students that they have committed to hiring full-time music teachers for all 45 of the district’s schools over the next 10 years. Music had been cut from nearly all of Chula Vista’s schools over the past decade, but last spring, the district reinstated school-day music classes for third graders at six of its schools.

According to Dalouge Smith, president and CEO of the San Diego Youth Symphony, not only have principals at Community Opus participating schools reported a decline in classroom disruptions and improved motivation, behavior, and attendance among students studying instruments, but these students also performed significantly better on fourth grade math and reading proficiency tests than students not receiving music instruction.

Ironically, these findings come at a time when 1.3 million of the nation’s public elementary school students receive no specific instruction in music—and the children who do not have access to music education are disproportionately those who attend high-poverty schools. While wealthier school districts can compensate for budget cuts that reduce or eliminate music programs with private funding, low-income school districts cannot, so the kids who might benefit most from music education are often the least likely to get it. “One certainly hopes,” Iversen says, “that the results of these kinds of studies will cause a re-evaluation of the role of arts education in schools.”