

Music Training Sharpens Brain Pathways, Studies Say

By Sarah D. Sparks

San Diego



At the Youth Orchestra Los Angeles, a student sits poised with her bow string at a practiced angle to her violin, her eyes following both the written notation in front of her and the conductor's direction, aware of both her own music and the sounds coming from fellow students' instruments.

New research suggests that the complexity involved in practicing and performing music may help students' cognitive development. Studies released last month at the Society for Neuroscience meeting here find that music training may increase the neural connections in regions of the brain associated with creativity, decisionmaking, and complex memory, and they may improve a student's ability to process conflicting information from many senses at once. Research also found that starting music education early can be even more helpful.

"It's really hard to come up with an experience similar to that" as an education intervention, said Gottfried Schlaug, the director of the **Music and Neuroimaging Laboratory** at Harvard Medical School. Not only does it require attention and coordination of multiple senses, but it often triggers emotions, involves cooperation with other people, and provides immediate feedback to the student on how well he or she is progressing, he said. Music, on its own, has also been shown to trigger the reward area of the brain, he noted.

Learning to Multitask

For example, a team of researchers led by Julie Roy, a postgraduate researcher at the auditory-neuroscience-research library at the University of Montreal in Canada, tested 15 musicians with 10 to 25 years of experience, as well as 15 nonmusicians of the same age, in sensory-processing tasks. The participants were asked to report touch sensations while also hearing sounds, ignoring what they heard, and reporting only what they felt on a finger. Prior research has shown that to be difficult to do; normally, those who feel one touch but hear two sounds will think they have felt two touches.

Longtime musicians, however, who must simultaneously read music, feel their instrument, and respond to the sounds it produces, were more than twice as accurate at distinguishing touch and hearing.

In another study, Yunxin Wang, a researcher at the **State Key Laboratory of Cognitive Neuroscience and Learning** at Beijing Normal University in China, examined the structures of the brains of 48 young adults ages 19 to 21 who had studied music at least one year between the ages of 3 and 15. After controlling for gender and the amount of time they had trained overall, Ms. Yunxin found those who had begun musical training before age 7 had significantly more-developed brain areas associated with language and executive function.

Ana Pinho, a neuroscientist at the Karolinska Institute in Stockholm, Sweden, argued that musical education can be helpful at any age. "Even after stroke and disease, starting musical training can still help you get more from your brain," she said. "All of these findings show [musical training] can create a lot of plasticity that can produce effectiveness across the brain, in cognition and behavior."

Ms. Pinho used functional magnetic resonance imaging to record the blood flow in the frontal lobes of 39 pianists while they improvised music on a specially designed keyboard. Musicians with longer experience in improvising music had better and more targeted activity in the regions of the brain associated with creativity and the ability to transfer working memory to long-term memory.

'Toolbox for Creativity'

While specific parts of the brain can be responsible for a motor task such as strumming a G-string, researchers are finding that a musician interpreting Johann Sebastian Bach's "Air on a G String,"—much less creating such a masterpiece—uses more of a brainwide process.

"We say that when people are inspired, they create, that it all comes in a rush," said Antonio R. Damasio, a neuroscience professor at the University of Southern California, "but, of course, it comes in a rush if you've trained your hands and your mind for an entire lifetime. That moment of inspiration generally comes on the back of a whole process of imagination and knowledge and criticism of what has come before."

"We want to know what circuitries are involved, but this is something about the whole brain, not left or right brain or some particular cortex," he said during a symposium about the neuroscience of creativity at the conference Nov. 8-14.

Mr. Damasio leads an ongoing longitudinal study by USC's Brain and Creativity Institute on the development of musical skills—and neurological development—of students in the Youth Orchestra Los Angeles. For the past year, the **Effects of Early Childhood Musical Training on Brain and Cognitive Development** project has worked with the youth orchestra, which provides free musical instruments and training to low-income students in the city. Researchers are tracking students for five years, beginning at ages 6 or 7, who have been matched in age, socioeconomic status, and prior cognitive ability.

Nikki Z. Shorts, the lead strings teacher and conductor of the Heart of Los Angeles site of the orchestra, said she has seen one band of sometimes rambunctious 1st graders develop into attentive 4th graders in the three years she has taught them.

"In order to cultivate the skills to sit and focus, they're like athletes: We exercise our brains and our bodies, and then we have to take a break, relax, and come back to it. And over time, that skill builds up," she said.

Moreover, the nonacademic setting can give students who have behavioral problems in school "a different way to focus on the skills of discipline and commitment," Ms. Shorts said. "They get to communicate emotion without words. Kids that are really closed off emotionally really open up."

As students take part in intense, group-based musical training over those years—two hours a day, five days a week—the USC researchers are tracking their cognitive, social-emotional, and physiological brain development, and comparing it to that of matched students who do not receive musical training but participate in sports activities at an equal intensity. At the same time, the study will analyze the development of the students' musical skills and creativity over time.



Kevin, 11, plays flute in the Youth Orchestra LA at the Heart of Los Angeles music program class in Los Angeles.

—Eric Grigorian for Education Week

“Several studies have provided compelling evidence that when the brains of adult musicians are compared to nonmusicians there are differences of function and anatomy,” said Assal Habibi, a USC postdoctoral researcher on the study. “Longitudinal studies in children are the only way to examine the relative contributions of nature and nurture to the differences found in adult populations.”

And insights to the ways music affects brain development may help researchers understand how students process other cognitively complex tasks, Mr. Schlaug said. For example, he has found that “musical disorders,” such as tone-deafness or the inability to distinguish and hold a beat, **affect 4 percent to 10 percent of the population**—the same percentages that have been identified with primary disabilities in other areas, such as dyslexia in reading or dyscalculia in mathematics. Moreover, a 2011 study by Mr. Schaug and his colleagues found among children ages 7 to 9, the ability to perceive pitch and phonemic awareness were correlated, suggesting there may be a connection or a shared neural cause of both dyslexia and tone-deafness.

“Having this toolbox of ways to examine creativity allows us to understand what brain regions are involved in creative thought and coming up with new ideas,” Harvard’s Mr. Schlaug said. “From a broader societal perspective, it is obviously important to strengthen creativity because that is the seed for coming up with new developments, new ideas, and new tools.

Does this mean states should set mandatory music-training requirements, as nearly all now do for physical education?

Probably not, according to Mr. Schaug. While studies show benefits of music training, so far they have only looked at students who are voluntarily participating, not those who are forced to play.

“You wouldn’t want to do an activity that wouldn’t be joyful and rewarding for anybody to do,” he said.

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