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MUSIC CHANGES LINKS IN BRAIN
Exposure to melody is found to have effect on neural structure.

NEW YORK - From Mozart to Miles Davis, the harmonies of music rewire the brain, creating patterns of neural activity at the confluence of emotion and memory that strengthen with each new melody, research made public Thursday shows.

By monitoring the brains of people listening to classical scales and key progressions in Western music, scientists at Dartmouth College glimpsed the biology of the hit-making machinery of popular song. The flash-dance of these brain circuits, which process the harmonic relationship of musical notes, is shaped by a human craving for melody that drives people to spend more every year on music than on prescription drugs.

"Music is not necessary for human survival, yet something inside us craves it, said Dartmouth music psychologist Petr Janata, who led the international research team. "Our minds have internalized music."

Whatever the reason, the impact on the individual brain is measurable.

Among expert musicians, certain areas of the cortex are up to 5 percent larger than in people with little or no musical training, recent research shows. In musicians who started their training in early childhood, the neural bridge that links the brain's hemispheres, called the corpus callosum, is up to 15 percent larger. A professional musician's auditory cortex -- the part of the brain associated with hearing – contains 130 percent more gray matter than that of non-musicians.

The new study, published today in Science, shows for the first time that the abstract knowledge about the harmonic relationships in music inscribes itself on the human cortex, guiding expectations of how musical notes should relate to one another as they are played. Through constant exposure, synapses are trained to respond like a series of tuning forks to the tones characteristic of Western music, several experts said.

The pattern in the music literally becomes a pattern in the brain. "It shows this link between music theory and perception and brain function," said Frances Rauscher, an expert in music cognition at the University of Wisconsin at Oshkosh. "No one had looked before."

The Dartmouth group scanned eight people with a functional magnetic resonance imager as they listened to an eight-minute melody specially composed to move continuously through all 24 major and minor keys. The volunteers, who each had about 12 years of musical training, performed several musical-related tasks while they listened in the scanner.

The scanner, which records changes in blood flow associated with mental processing, allowed the scientists to watch this meandering of keys as the music raced a path across the surface of the cortex.

Although music activated many parts of the brain, the researchers discovered that everyone had just one area in common that tracked and processed melodies. That brain region, located near the center of the forehead, is called the rostromedial prefrontal cortex. This region, which links to short-term memory, long-term memory and emotions, is different from areas involved in more basic sound processing.

"In the same way that tracing the path of a car allows one to infer the underlying map of a city's streets, the path traced by the keys along the cortex allowed the researchers to see the underlying structure," said David Huron, head of the cognitive and systematic musicology laboratory at Ohio State University.

"It is beautiful," Huron said. Since the first primitive human ancestor carved a flute from a bear bone more than 50,000 years ago, melody, harmony and rhythm have stirred people of every culture. No one knows how or why music evolved to become such an important human activity.

"Music is really popular. But what does it do for the brain?" said Janata. "Why is it we have the emotional responses we do to music? Why is it that melodies run spontaneously through our heads?"

Music may be as much in the genes as in the soul.

Perfect pitch, for example, appears to be inherited, only to be lost if not reinforced by practice. By 4 months of age babies already prefer the more musical intervals of major and minor thirds to the more dissonant sounds of minor seconds, researchers have shown.

Gordon Shaw and Mark Bodner, brain experts at the Music Intelligence Neural Development Institute in Irvine, California, emphasized, however, that there is nothing special about Western music, a least as far as brain anatomy and neural networks are concerned. These distinctive musical circuits in the cortex could be just as easily tuned by exposure to the music of the Aborigine didgeridoo, Tuvan throat-singing or Japanese court gagaku.

"This is a brain structure that has adapted to the way the music is," Huron said. "This is a manifestation of Western culture that is appearing on the cortex, not some innate structure."

Within this brain region, however, a melody creates a slightly different pattern of neural activity every time it is heard, as if the laser-reading the digital pattern of a compact disc recording varied the pattern slightly each time the music was played.

This dynamic map may be the key to understanding why a piece of music might elicit a certain behavior one time, like dancing, and something different another time, like smiling when remembering a dance, the researchers said.

"We think it might explain why when you hear a piece of music one time, it might move you to dance," said Janata. "When you hear it another time, you might instead remember the party or the feelings you had there."

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