Health and Science

MUSIC ON THE BRAIN

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It's hard to exaggerate the effect music can have on the human brain. A mere snippet of song from the past can trigger memories as vivid as anything Proust experienced from the aroma of his petite madeleine. A tune can induce emotions ranging from unabashed joy to deep sorrow and can drive listeners into states of patriotic fervor or religious frenzy--to say nothing of its legendary ability to soothe the savage beast.

Yet in spite of music's remarkable influence on the human psyche, scientists have spent little time attempting to understand why it possesses such potency. "We tend to think of music as an art or a cultural attribute," notes Robert Zatorre, a neuroscientist at McGill University in Montreal,

> "but it is a complex human behavior that is as worthy of scientific study as any other."

That's why Zatorre helped organize a conference, "The Biological Foundations of Music," sponsored last week by the New York Academy of Sciences, at which experts in disciplines ranging from neuroscience and neurology to brain imaging and psychology met to exchange notes about what's known--and, more important, what remains to be learned--in this small but growing field.

What seems clear is that the ability to experience and react to music is deeply embedded in the biology of the nervous system. While music tends to be processed mostly in the right hemisphere of the brain, no single set of cells is devoted to the task. Different networks of neurons are activated, depending on whether a person is listening to music or playing an instrument, and whether or not the music involves lyrics.

Specific brain disorders can affect the perception of music in very specific ways. Experiments done on epileptics decades ago showed that stimulating certain areas of the temporal lobe on both sides of the brain awakened "musical memories"--vivid re-creations of melodies that the patients had heard years earlier. Lesions in the temporal lobe can result in so-called musicogenic epilepsy, an extremely rare form of the disorder in which seizures are triggered by the sound of music. Autism offers an even greater puzzle. People with this condition are mentally deficient, yet most are proficient musicians; some are "musical savants" possessed of extraordinary talent.

The opposite is true of the less than 1% of the population who suffer from amusia, or true tone deafness. They literally cannot recognize a melody, let alone tell two of them apart, and they are incapable of repeating a song (although they think they are doing it correctly). Even simple, familiar tunes such as Frere Jacques and Happy Birthday are mystifying to amusics, but when the lyrics are spoken rather than sung, amusics are able to recognize the song immediately.

"This goes way beyond an inability to carry a tune," observes psychologist Isabelle Peretz of the University of Montreal. "They can't dance, and they can't tell the difference between consonance [harmony] and dissonance either. They all appear to have been born without the wiring necessary to process music." Intriguingly, people with amusia show no overt signs of brain damage or short-term-memory impairment, and magnetic-resonance-imaging scans of their brains look normal.

There is evidently no way to help these unfortunate folks (though, admittedly, they don't know what they're missing). But for instrumentalists, at least, music can evidently trigger physical changes in the brain's wiring. By measuring faint magnetic fields emitted by the brains of professional musicians, a team led by Christo Pantev of the University of Muenster's Institute of Experimental Audiology in Germany has shown that intensive practice of an instrument leads to discernible enlargement of parts of the cerebral cortex, the layer of gray matter most closely associated with higher brain function.

As for music's emotional impact, there is some indication that music can affect levels of various hormones, including cortisol (involved in arousal and stress), testosterone (aggression and arousal) and oxytocin (nurturing behavior) as well as trigger release of the natural opiates known as endorphins. Using PET scanners, Zatorre has shown that the parts of the brain involved in processing emotion seem to light up with activity when a subject hears music.

As tantalizing as these bits of research are, they barely begin to address the mysteries of music and the brain, including the deepest question of all: Why do we appreciate music? Did our musical ancestors have an evolutionary edge over their tin-eared fellows? Or is music, as M.I.T. neuroscientist Steven Pinker asserts, just "auditory cheesecake," with no biological value? Given music's central role in most of our lives, it's time that scientists found the answers.