Psychology of Music

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Alan Aversa
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Professor Scott Jacobs

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Music is the arrangement of sound in a linear fashion so as to create an aesthetically pleasing succession of notes. Every culture, from the Inuit in North America to the Chinese in Asia to the Italians in Europe, has music. It defines a culture, passes on traditions, tells stories, evokes emotions. Creating it, playing it, and listening to it involves almost every neurological process of the human brain, but what is music exactly (Zatorre, 2005, p. 312)? Why does it evoke emotions? What's its evolutionary purpose? Ultimately, why do humans listen to it, often daily?

One way to study the neurology of music processing is to study those few people with an absence of this ability. The syndrome known as amusia, or musical agnosia, is characterized by the inability to perceive or retain memory of music often due to an infarct, such as an aneurysm in the brain, or because of a surgical procedure to relieve epileptic patients from seizures. Commonly amusia is known as "tone deafness" since patients cannot discern dissonances (Abbott, 2002, p. 13).

A pioneer of a standard model of amusia, Isabelle Peretz at the University of Montreal, herself a classical guitarist, posed that there are two types of this form of agnosia. The first is apperceptive agnosia, characterized by the inability to convert auditory information into a form useful for perceiving the melodies or temporal structures of music, and the second is associative agnosia, where the patient cannot retain in memory musical elements but usually can perceive music's melody and rhythm. Thus Peretz hypothesized that there are two neurological systems, a perceptual analysis and a representation system which work together in musical recognition. Auditory input is temporally and melodically organized in the perceptual analysis system and is then fed to the representation system where it is stored in memory, the brain's musical "repertoire" repository. An infarct in the part of the brain responsible for either or both of the two main systems involved in musical understanding may be the cause for apperceptive or associative amusias (Ayotte *et al.,* 2000, p. 1926-1938).

Peretz and Julia Ayotte of the University of Montreal compared twenty patients with amusia because of a left, right, or bilateral aneurysm of the middle cerebral artery against a control group with normal musical recognition abilities in their study in 2000. Because melodic features are more easily remembered than rhythmic structures of music, they played both universally familiar melodies and novel melodies with equal rhythmic structure to their patients. After listening to the melodies, perceptual recognition tests involved asking them whether a tune was "old" if it was already heard or "familiar" if it was a well-known melody but not heard in the experiment. To test perception, two tunes, either the same or different, were played in a row. The patient was asked to tell if the tunes were "different" or the "same." Ayotte *et al*. concluded, using computerized axial tomography (CAT) scan images, that damage to structures in the right hemisphere is responsible for apperceptive amusia, and damage to those in the left hemisphere results in associative amusia.

Other interesting experiments on music perception are those on pre-linguistic infants, typically younger than six months old. Placing speakers in their cribs, experimenters played consonant and dissonant versions of a tune noticing the children tend to show visible signs—such as squirming, gaze aversion, or loss of attention—when dissonant versions were played. Notes with frequencies of small integral ratios, such as the perfect fifth (3:2) and perfect fourth (4:3), were tolerated more so than the dissonant tritone with a 43:32 frequency ratio. The same is true for adults and to a certain extent, primates. Human infants, however, are universalists in that they can recognize dissonances in foreign, non-Western scales like the Javanese scale system (Trehub, 2003, p. 669-672).

The fact that the acoustics of music has such an effect on one's perception of dissonance or consonance coupled with the fact that pre-linguistic infants are musical universalists suggests that music perception is more so because of nature than nurture. Because infants are often able to sing or melodically vocalize before language acquisition, they must have a predisposition to music generation and processing. The social element of music has been a leading theory as to the utility of music, and this can be seen when a mother sings to her infant. She often uses a narrow pitch range, simple melodies, and repetition in her lullabies to bond with her child or to calm him. When the child matures, music will connect him with others and synchronize his "flow of neural activity" with others' neural activities, suggests W. Benzon (Trehub, 2003, p. 671-672).

Music has purportedly increased the intelligence quotient (IQ) scores of developing children exposed to music as compared to those children without the privilege of music education early in their lives. Although this does not imply that children are necessarily more intelligent when they can play the violin, for example, it does predict that they should have a higher aptitude for performing well in school. Even post-pubescent aged college students have increased their IQ scores by 8 to 9 points as a result of listening to Mozart's *Sonata for Two Pianos, K.448*. This has become known as the "Mozart effect" (Chabris, 1999, p. 826-827).

Because music is an arrangement of notes following very specific syntactic rules of meter, or rhythm, and dynamics, or levels of volume, and because infinitely many songs can be recursively generated from simple phonemes or tones, music is similar to language. It lacks a semantic structure in the way that spoken language can convey meaning, but it can successfully emote. For example the baroque composer Antonio Vivaldi's famous *Four Seasons* concerti convey emotions remarkably similar to the emotions conveyed in four sonnets he himself wrote about his concerti. Thus humans could use the same faculties for music as for language processing and generation.

If music is language-like, how does one prove if it is merely an extension of humans' linguistic abilities? There exists some interesting evidence. The fact that people with amusia have no difficulty in distinguishing a question with a rising intonation ("It is good?") from a statement with no interrogative intonation ("It is good.") suggests that language and music faculties may not be interrelated (Abbott, 2002, p. 13). But that language and music development in children follow similar "developmental time courses," regardless if similar neural substrates are employed for both music and language, show that there are similarities between the ways music and language are treated in the human brain (Zatorre, 2002, p. 37). Generally, the left hemisphere is where speech is processed because there it can process audio with enhanced temporal resolution, and the right hemisphere is better suited for auditory processing with higher tonal resolution where it can recognize melodies and musical motifs in general (Sininger *et al.*, 2004, p. 1581). If the left hemisphere is where language and logic are processed, it is not improbable that language and music are intertwined at the neural level there, too, or that music is a result of humans' linguistic abilities.

What is more mysterious, on the other hand, is the origin of one's emotional response to a moving piece of music. Anne J. Blood and Robert J. Zatorre, using positron emission tomography (PET), studied the brains of subjects with musical training who witness pleasurable "chills" or "shivers-down-the-spine" when subjected to a pleasing classical music composition of their choice. Their findings, along with a previous study on the effects of dissonance on regions of the brain associated with emotion—the ventral striatum, mesencephalon, amygdala, the ventral media prefrontal cortex, and the orbitofrontal cortex—show that "chills" resulting from music are similar to humans' response to other euphoric stimuli such as food, sex, or illegal drugs and that the emotional regions and cortices involved with these activities are also involved with music processing. Blood *et al*. hypothesize that music is one of a human's essential needs; it is linked "with biologically relevant, survival-related stimuli via [its] common recruitment of brain circuitry involved in pleasure and reward" (Blood *et al*., 2001, p. 11818).

Through archaeology scientists know that people have been making music for thousands of years. The famous Lyre of Ur of the Iraq National Museum has been dated to be forty-thousand years old (McTague, 2004, p. 1). This suggests that there must be something special about the human genome compared to human's primate relatives that allows humans to create and interpret music. In fact there is a genetic component to musical aptitude, at least in the realm of pitch recognition. Dennis Drayna of the National Institute on Deafness and Other Communication Disorders administered a Distorted Tunes Test (DTT) to adult monozygotic (MZ) or identical twins and dizygotic (DZ) or non-identical twins in 2001. The DTT plays either a correct or a tonally distorted version of a tune and asks the patient if the tune was played correctly or not. He found that the correlation r in test scores between MZ twins was 0.67, and between DZ twins it was only 0.44 suggesting a strong genetic component to tone deafness or lack thereof. Employing genetic-model fitting, Drayna even estimated the heritability of tone perception to range from 0.71 to 0.80 (Drayna *et al*., 2001, p. 1969). That musical abilities are genetic is corroborated by Zatorre *et al*. (2002, p. 40) who suggest that the hemispheric temporal-frequency lateralization is an evolutionary optimization so that human auditory systems can perceive high or low temporal or spectral resolutions when needed, such as for speech or for music. Therefore, from a biological standpoint, human musical abilities must have resulted from an evolutionary optimization of linguistic and auditory abilities.

Research on amusia, the musical abilities of infants, the differences and similarities among music, language, and speech, the emotive properties of music, and the genetics of music perception have given psychologists a deeper understanding of the inner-workings of the amazing human psycho-acoustical system. More experiments and research on these topics in the future will lead to a better, fuller understanding of the complexity and uniqueness of the human mind and its ability to make music.

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