How Music Can Literally Heal the Heart

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MEDICINE

How Music Can Literally Heal the Heart

Its structural attributes and physiological effects make it an ideal tool for learning cardiology, studying heart-brain interactions and dispensing neurocardiac therapy

By
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In a maverick method, nephrologist Michael Field taught medical students to decipher different heart murmurs through their stethoscopes, trills, grace notes, and decrescendos to describe the distinctive sounds of heart valves snapping closed, and blood ebbing through leaky valves in plumbing disorders of the heart.

Separately, in music based on electrocardiographic (ECG) traces of heart rhythm disorders, one of us—musician-mathematician Elaine Chew—used music notation to

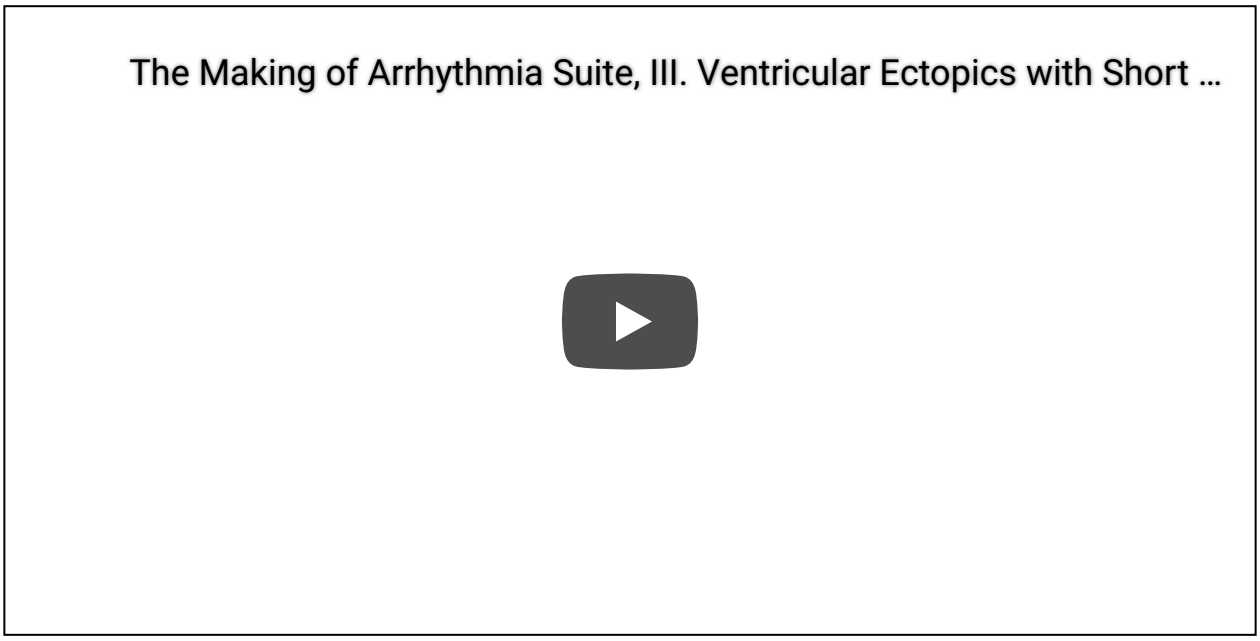
capture the signature rhythms of electrical anomalies of the heart. Collaged from extant music fragments matching the heartbeats, Brubeck's *Blue Rondo à la Turk* provided the 2:4:3 rhythmic tattoo of ventricular early beats, Piazzolla's *Le Grand Tango* remixed produced the irregular rhythms of atrial fibrillation. *Little Etudes for piano*, with pedagogical descriptions by cardiologist Pier Lambiase, provided a layperson's introduction to electrical aberrations of the heart.

The reason these heart-music mappings work is because abnormal heart rhythms tend to form simple inter-beat-interval ratios. In fact, the distinctive rhythms in Beethoven's music so closely resemble those of heart rhythm disorders that cardiologists have speculated that they may be transcriptions of Beethoven's possible arrhythmia, his interoceptive awareness of his own heartbeat enhanced by his deafness.

This is but one of multiple reasons music should be part of every heart physician's toolkit. Music and the heart have been romantically linked in popular consciousness due to their shared connections to human emotions and the brain. History is replete with examples of emotionally charged events followed almost immediately by the death of the person. The surgeon John Hunter famously pronounced, "My life is at the mercy of any scoundrel who should put me in a passion," before collapsing and dying after a heated board room meeting.

Cardiologists Peter Taggart and Pier Lambiase have been studying how emotions alter the conductive properties of individual heart cells. Mental stress changes the recovery period of heart cells after each heartbeat, called the action potential duration. Taggart co-authored a study in which patients whose hearts were paced at a steady rate watch the harrowing "cut the rope" scene from Vertical Limit (2000). The patients' action potential duration shortened under the stress. This may explain how more extreme stress coupled with underlying cardiac disease could precipitate life-threatening arrhythmias.

Acute stress produces dramatic effects in the heart, but slow-burning chronic stress due to protracted insecurity also predispose sufferers to disease and mortality. The sympathetic nervous system's default state of high alertness is suppressed when safety is perceived; these safety brakes are lifted under duress. The Generalized Unsafety Theory of Stress co-written by psychophysiologist Julian Thayer links the unconsciously perceived unsafety of prolonged stressors like low social status, early life adversity or loneliness to hypervigilance that increases the odds of developing heart disease.



Music moves us in part because it draws on our primal intuitions about the heartbeat. Until the mid-19th century when it was replaced by the mechanical metronome, the human heartbeat provided the standard unit of measure for musical time. In his 1496 treatise, the *Practica Musicae*, the composer-theorist Franchinus Gaffurius wrote that

the proper measure of the musical beat should be the pulse of a healthy human, noting that the pulses of "fevered persons" undergo an increase or become unequal in ways that worry physicians.

When we connect to the pulse of the music, we sense another's physiological states. The steady pulse at the beginning of Schubert's *Trio, Op. 100*, sets a strong but serene pace for its haunting melody. The breathless octaves in the opening of *Der Erlkrönig* evokes the rapid heart palpitations of the fevered boy in his father's arms, galloping through the stormy, windswept night. Hearing just heartbeats, pulse-only music, has been found to increase listeners' ability to sense what others are feeling in a study co-authored by musician-scientist Grace Leslie.

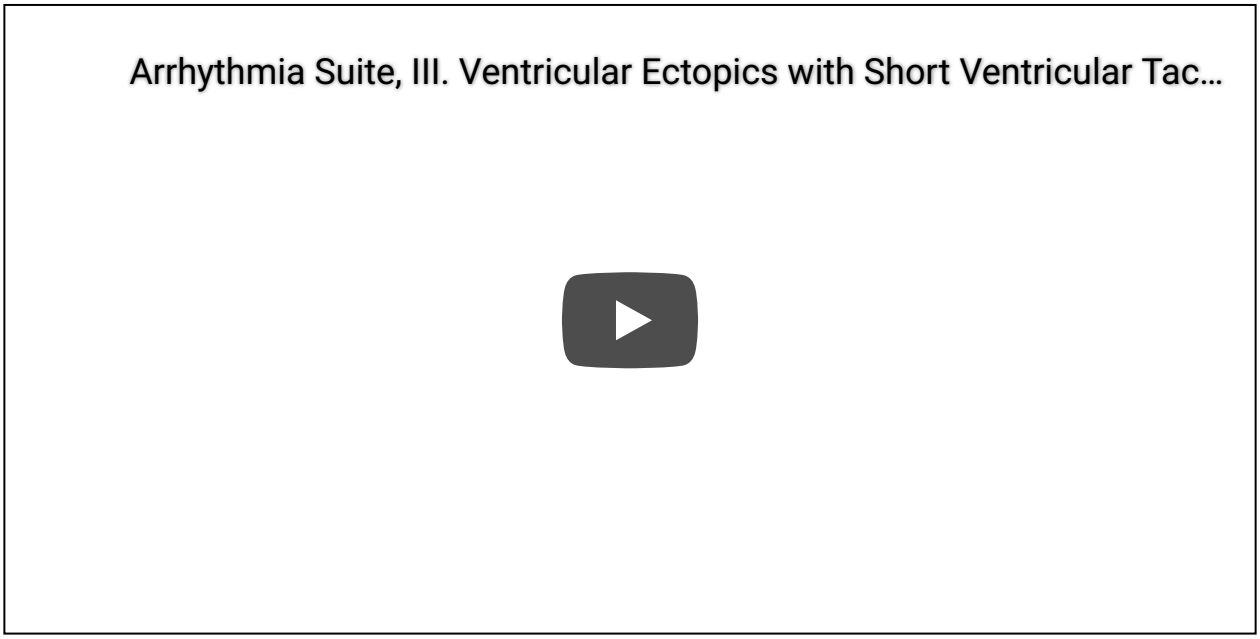
Music changes our heartrates, breathing, and blood pressure, and alters our heart rate variability, indicators of cardiac and mental health. Neuroscientist Psyche Loui and colleagues have traced music-induced physiological changes to a central node in the brain's networks, called the anterior insular, with dense connections to the vagus nerve, responsible for unconscious regulation of body functions.

The anterior insula is associated with empathetic mirroring of external and internal experiences. It is also connected to parts of the brain responsible for hearing (the auditory cortices) and for pleasure (the dopaminergic reward system). These auditory and reward network pathways likely subserve the mind's ability to form predictions and expectations during music listening. The systematic fulfilment and violation of expectations are thought to underlie emotion and meaning in music.

Music is an ideal catalyst for inducing physiological changes in heart-brain studies because it can be dissected systematically into features based on note content and the way this content is communicated in performance. Evidence suggests that these musical attributes trigger brain responses at a basic level. Analyzing listeners' brain imaging data in the OpenFMRI Study Forrest dataset, composer-neuroscientist Michael Casey found

that specific music features induced predictable activation patterns in regions of listeners' brains. The activation patterns were consistent enough for machines to infer the music the listener heard or its genre simply from their fMRI scans.

Music features have also been linked to physiological responses. In a study co-authored by physicians Luciano Bernardi and Peter Sleight, loudness increases in vocal and orchestral music produced vascular constriction and blood pressure increases proportionate to these crescendos. Verdi arias with ten-second-long phrases—the period of Mayer waves, the body's natural blood pressure oscillation—caused listeners' heart and respiratory signals to sync with the music envelop. Such unconscious physiological responses are thought to be the progenitors of music-induced emotions.

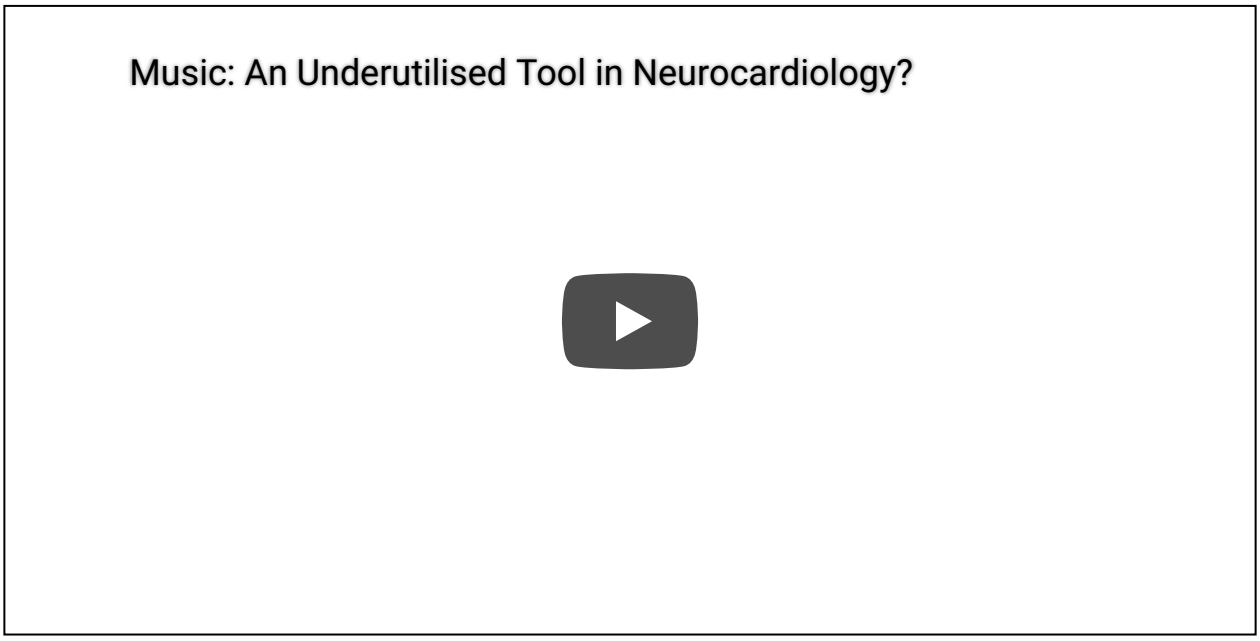


Music also has a communal impact on human physiology. People listening to the same music tend to synchronize not only their movements, but also their breathing and heart rhythms. Some of this heartbeat coherence is due to breathing together, but partial coherence (linear relationships) remained higher between the heartbeats of people vocalizing long notes together, over the baseline or breathing together, even after removing the effect of respiration.

The cognitive and physical demands of playing music also have measurable effects on musicians' heart rhythms and breathing patterns. Psychologists Caroline Palmer and

Shannon Wright showed that repetitiveness of musicians' heart rhythms show greater rigidity (predictability) when playing unfamiliar musical melodies, and also when playing first thing after waking in the morning rather than in the evening.

For cardiac patients, music-based interventions can also modulate cerebral blood flow, reduce pre-operative anxiety and post-operative stress, improve surgery outcomes, and lower cortisol levels. Music interventions are found to significantly affect heartrate and blood pressure in coronary heart disease patients. Listening to relaxing music not only reduced heart and respiration rates but also oxygen demand of the heart in patients who have had a heart attack.



Technological advances in biofeedback sensors means that physiological parameters like heartbeats and heart rate variability can be harnessed to guide music interventions in cardiac therapy. Physiological feedback can be used to select or shape music to influence listeners' heart rates and breathing, for example, to increase heart rate variability. With widespread adoption of biofeedback devices, the tailoring of music interventions to individual cognitive or neural-cardiac states is now well within reach enabling a "musical prescription" for improved mental and physical wellbeing.

This is an opinion and analysis article; the views expressed by the author or authors are not necessarily those of Scientific American.

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