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Music as a pharmaceutical alternative

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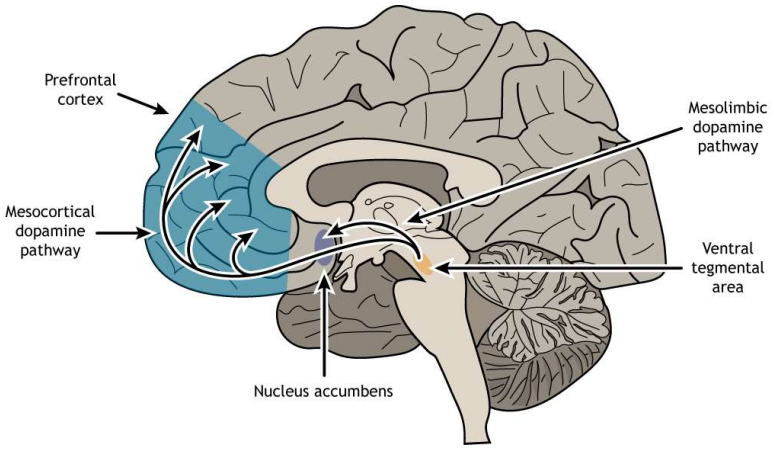
"*After silence, that which comes nearest to expressing the inexpressible is music.*"

The words of Aldous Huxley depict the unique ability of music to convey emotion and summon an instinctual sentimental response within us all. Although many believe this to be an ineffable reaction which defies scientific explanation, a growing body of research appears to suggest otherwise. This research has inspired a resurged interest in the application of music for the enhancement of cognitive processing and treatment of symptoms associated with some of humanity's most pervasive diseases. The result is a new wave of technology which is using artificial intelligence to understand how music generates these effects, with the intention of developing music as a therapeutic alternative to some pharmacological treatments.

Advances in cognitive neuroscience suggest that neurochemical changes within the brain—specifically activation of the mesolimbic and mesocortical pathways (also known as the pleasure and reward pathways) which constitute the mesocorticolimbic system—are responsible for the way in which music alters our mood. The mesocorticolimbic system extends from the ventral tegmental area (VTA) through the nucleus accumbens (NAc) to the prefrontal cortex. It is thought that dopaminergic neurons in the VTA are activated in response to music, and that their projections to the NAc and prefrontal cortex result in the release of endogenous opioid peptides which produce feelings associated with pleasure.



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Many of us are familiar with the experience of frisson that can arise when listening to an especially emotive piece of music. This sensation is associated with a significant increase in cerebral blood flow within the structures which comprise the mesocorticolimbic system, and the intensity of the sensation correlates with the amount of dopamine released as a result. Studies even suggest that this sensation may be inhibited under administration of the opioid antagonist, naloxone, providing further evidence of a causal link between the release of endogenous opioids and this heightened sensory experience.

This understanding may help to explain the particularly interesting observation that patients instructed to self-administer morphine to relieve post-operative pain whilst listening to music used significantly less of the drug than a control group. This suggests not only that music has the capacity to cause pleasure, but that it may be able to activate the mesocorticolimbic system sufficiently to induce pain relief. With the knowledge that the neural network activated by music is also stimulated by more conventional, well-understood stimuli, such as psychostimulants, the idea that music may, at minimum, act as a complementary mode of pain relief does not appear to be so far-fetched.

Aside from exploring the potential for music as an analgesic, much research has been carried out to better understand how it can be used to reduce stress—a particularly worthwhile endeavour given the causal relationship which has been established between chronic stress and diseases including cardiovascular disease, Alzheimer's and depression.

Several neurochemicals mediate the stress response within the body. These include glucocorticoids (for example, cortisol), which regulate metabolism and immune function, and catecholamines (norepinephrine and epinepherine) which induce cardiovascular changes. Prolonged, elevated levels of glucocorticoids have been shown to weaken the ability of cells to resist injury, thereby increasing their vulnerability to the effects of toxins and attrition, and it is thought that prolonged, elevated levels of glucocorticoids promote an undesirable chronic state of low-grade inflammation.

Non-rhythmic "meditative" music has been shown to significantly reduce plasma levels of cortisol and norepinephrine when compared to silence, and listening to "relaxing music" (generally considered to have slow tempo and low pitch) when in a post-operative state has been shown to result in a significantly greater decrease in serum cortisol compared to controls. One study has even compared the effects on pre-operative anxiety of benzodiazepine to relaxing music compiled by a licensed music therapist—both baseline anxiety and heart rate were reduced significantly more by the music than the drug.

One proposed mechanism for the ability of music to regulate stress is that music modulates reflexive brainstem responses which mediate measures including heart rate, pulse, blood pressure, body temperature, skin conductance and muscle tension. Through cerebellum activation, the brain synchronises neural oscillators with tempo thereby altering these parameters. It is this mechanism that is thought to generate the unconscious "groove" felt when listening to music: the brain starts to predict when the next strong beat will occur.

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MediMusic is one UK-based company which has taken note of the numerous benefits listening to music is thought to have on the body, and—using data analytics, AI and machine learning—is determining the causal link between various musical features and the brain's response in order to create playlists that have the capacity to function as a precision medicine. It is exciting to watch this technology develop, and to discover how accurate a medicine could be produced, and how far-reaching its application could become.

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NOTES (IGNORE)

Neurochemistry of music

https://daniellevitin.com/levitinlab/articles/2013-TICS_1180.pdf

https://www.ucf.edu/pegasus/your-brain-on-music/

https://www.medrhythmstherapy.com/scientific-approach/

Goosebumps

https://www.classicfm.com/music-news/music-gives-goosebumps/

Entrainment

https://en.wikipedia.org/wiki/Entrainment_(biomusicology)#cite_note-2

Medrhythmns (using entrainment to improve gait, recovery after traumatic brain injury such as stroke, parkinsons, autism)

https://www.medrhythmstherapy.com/what-is-nmt/

Sync Project

https://www.wired.co.uk/article/sync-project-music-ai-sleep

http://syncproject.co/

Max Richter – 8 hour sleep

https://www.sxsw.com/world/profile/2018/exploring-science-sleep-max-richter/

https://www.independent.co.uk/arts-entertainment/classical/features/max-richters-sleep-the-longest-continuous-piece-of-music-broadcast-by-the-bbc-10502454.html

Tom Middleton – sending to sleep

https://www.bbc.co.uk/news/newsbeat-43290567

Marconi Union – Weightless

https://www.inc.com/melanie-curtin/neuroscience-says-listening-to-this-one-song-reduces-anxiety-by-up-to-65-percent.html

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NASA spinoff

https://spinoff.nasa.gov/Spinoff2015/hm_2.html

Music has been shown to modify heart rate, respiration rate, perspiration and autonomic systems.