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Applications and Physiological Mechanisms of Music Therapy in Insomnia Patients

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ABSTRACT

Music has long been an inherent aspect of culture and self-expression. Recently, music has also been used as a form of therapy because of its distinctive ability to relieve stress and promote relaxation in the human body. This has been found to be especially useful as a treatment for stress-linked disorders such as primary insomnia, which is characterized by increased sympathetic nervous system activity (Jerath, R., Beveridge, C., & Barnes, V. A., 2021). Secondary research conducted through a literature review showed that music processing is a "whole-brain activity" (Warren, J., 2008). Stimulation of pleasure centers and regions of the brain which control biorhythms, such as the brain stem, improves mood and promotes relaxation, and therefore better sleep, by releasing hormones such as dopamine and serotonin (Harvard Health, 2021). Music therapy's unique potential as a widely accessible form of therapy inspired me to write this article on the mechanisms in which this form of therapy fosters the well-being of insomnia patients. As the fast-paced lifestyles of many individuals has led to a rapid increase in stress-linked insomnia patients, an effective method of treatment should be available to all.

Introduction

Insomnia is currently the most prevalent sleep disorder in the US, affecting 10-15% of the general population, and is characterized by issues in initiating and maintaining sleep. Primary insomnia refers to cases in which underlying conditions are not at play, whereas secondary insomnia is insomnia that is linked to mental or physical conditions. Insomnia has also been linked to stress, which can result in either temporary or chronic insomnia (Ahn, D. H., 2013). Current treatments for insomnia include cognitive-behavioral therapy (CBT), prescription medications, and over-the-counter sleep medications (Sleep Foundation, 2020). CBT for insomnia may include stimulus control therapy (removing factors that inhibit restful sleep), relaxation techniques, sleep restriction, and light therapy (using light to reset or "push back" circadian cycles). Currently, common sleep medications include Eszopiclone, Zolpidem, and Ramelteon (Mayo Foundation for Medical Education and Research, 2016). However, these medications often have side effects such as tiredness during the day, lack of tolerance, or dependence on the medication. Additionally, patients do not always have access to the medications. According to the International Journal of Indian Psychology (2015), "Despite the wide availability of pharmacological treatments and increased knowledge of behavioral interventions, the vast majority of individuals with insomnia do not appear to be receiving adequate treatment". This inspired me to find an alternative method of treatment: music therapy.

Music therapy is the clinical use of music as a form of therapy. It is often performed with a music therapist, who is typically a musician; however, more recently, music therapy has been conducted remotely and by audio recordings. Music therapy is split into two major categories: active and passive music therapy. For reasons that will be elaborated on later, active music therapy is often more effective, and can still be performed remotely (McPherson, T., Berger, D., Alagapan, S., & Fröhlich, F., 2019). Because of this, music therapy will likely have wider accessibility than traditional forms of treatment. This makes it an extremely valuable method of treatment, especially when effectiveness is increased by combining music therapy with other methods of treatment such as medications.

Listening to and processing music involves many areas of the brain, including those that promote relaxation, evoke emotion, and are dopaminergic (involved in the release of dopamine). However, the specific mechanisms in which music therapy functions are not yet confirmed. Although this lack of primary research poses a significant limitation, this article attempts to explain one possible hypothesis. Regardless of its specific mechanisms, music therapy has had many positive results in patients including but not limited to fluid movement in people with Tourette's syndrome, improved mental health, reduced pain, and improvements in autism patients (Warren, J., 2008).

Methods

Secondary research was conducted through a literature review using search engines such as Google Scholar and PubMed. Papers used were limited to those published in the past twenty years, although many papers fell into this category because interest in the field has been especially common in recent years. Key terms used to narrow the scope of the research included music therapy, insomnia, music therapy insomnia, active music therapy, music therapy physiology, and music therapy stress. Since many papers used included references to Daniel Levitin's *This Is Your Brain On Music: The Science of a Human Obsession*, this work was also included. For information that is widely cross-referenced such as descriptions of common hormones, articles from Healthline.com and WebMD were used.

The method of analysis was to look for common themes among research papers in regards to physiological pathways and health benefits. Many studies confirmed my expectation that music therapy is effective, however, a lack of primary research concerning physiological mechanisms left significant ambiguity as to *how*. Because of this, research became limited strictly to the physiological mechanisms of music therapy.

Discussion

Benefits of Music Therapy

Arts-based therapies are becoming an increasingly popular form of treatment for new diseases and syndromes that are emerging as a result of stress—this includes music therapy. Studies have seen a wide range of benefits to such forms of therapy, including the normalization of blood pressure, improved mood, improved movement, and pain relief (Shakarashvili, M., & Arabuli, M., 2016). Additionally, while not all individuals experience strong reactions to music therapy, no negative reactions have been recorded. Specific to insomnia, music therapy and CBT combined are more effective in improving overall sleep quality and reducing symptoms than CBT on its own. Music therapy has also been shown to increase melatonin secretion, although the reasons for this are not confirmed. However, listening to sedative music causes relaxation in most individuals, which may reduce neuroendocrine and sympathetic nervous system activity and ultimately contribute to better sleep ScienceDirect Topics. (n.d.).

Music therapy also has a profound effect on emotion. According to Oliver Sacks,“ We turn to music [...] because of its ability to move us, to induce feelings and moods, states of mind”. This is especially helpful in individuals who have conditions that make communication more difficult, such as people with autism or frontal lobe syndromes. Music allows them to access strong emotional states and “regain cognitive focus” without the need to respond to language. Music can also evoke memories or emotional states of earlier events in individuals who suffer from memory loss (Sacks, O., 2006).

Music therapy may reduce stress by distracting people from negative stimuli, which can also result in anxiety reduction and pain relief. This relates to the concept that music can evoke powerful emotions, likely because of brain stimulation, which will be discussed later in this article. Additionally, a study found that music therapy can modulate heart-rate variability (HRV) and salivary stress markers (McPherson, T., Berger, D., Alagapan, S., & Fröhlich, F., 2019). These are physiological markers of the autonomic nervous system and the hypothalamic-pituitary-

adrenal (HPA) axis, which are directly involved in rest and relaxation. This implies that music may be able to modulate sleep.

In a study specifically targeted towards improving the overall quality of sleep for people who suffer from primary insomnia, researchers collected sixty-six subjects over the age of sixty from an adult day center. Nine subjects were male, and fifty-seven were female; the average age was 68.08, with a standard deviation of 6.18. All subjects were diagnosed with primary insomnia, willing to participate, had a sleep efficiency of below 80 percent, were literate, and gave written consent for attending the treatment program. Music therapy intervention was applied to the experimental group through a CD that contained sedative music which was used for 45 minutes prior to sleeping. In addition, energetic music was played in the morning. By measuring the level of the disorder before and after music therapy intervention and utilizing statistical software that analyzed data by multivariate analysis of covariance, the study concluded that music therapy was effective in improving sleep quality through surveys (Mottaghi, R., Kamkar, A., & Mardpoor, A., 2015).

Forms of Music Therapy

Music therapy has been split into two main classes: active and passive music therapy. Active music therapy refers to rhythmic engagement with the music, which can be achieved through actions such as tapping along with the beat, humming, or singing. Patients may find this method more interesting or more engaging than passive music therapy, which is simply listening to music. A study concluded that active and passive music therapy differentially modulate autonomic nervous system activity, which as previously stated, plays a critical role in relaxation (McPherson, T., Berger, D., Alagapan, S., & Fröhlich, F., 2019). Researchers contrasted the effects of active and passive music therapy by gathering sixteen individuals who experienced forty minutes of either active or passive music therapy. Both before and after the session, heart-rate variability recordings and saliva samples were collected and compared. Saliva samples were also analyzed for alpha-amylase and cortisol, which indicate the amount of sympathetic nervous system activity. The study found that active music therapy was more effective in decreasing the ratio of low-frequency to high-frequency components (LF/HF), a marker of the autonomic nervous system. This suggests that active and passive listening differentially modulate sympathetic nervous system activity.

Another component of music therapy is the choice of music. Previously, it was thought that only listening to classical music could result in health benefits such as a reduction in stress and anxiety levels. However, studies now show that any self-selected music is effective, provided that the individual perceives listening to the music as enjoyable (Levitin, D., 2020). According to the American Music Therapy Association, this is because self-selected music "provokes responses due to the familiarity, predictability, and feelings of security associated with it." Also, patients may engage with self-selected music more than music chosen by a therapist, which will be more effective as a method of treatment. This is logical when combined with the concept of active music therapy because interacting with music by humming along, counting beats, or anticipating what will come next activates more regions of the brain that have been associated with emotional responses, the release of dopamine, and stress reduction. All of these effects improve sleep quality.

Music and the Brain

The specific physiological mechanisms in which music therapy functions likely relates to the processing of music. Likely because of its countless components such as pitch, tempo, rhythm, and timber, music has been found to be a “whole-brain activity”, which means that many areas throughout the brain are involved (Sacks, O., 2006). Like any other sound, music passes through the inner ear and is processed in the ascending auditory pathway from the cochlea to the primary auditory cortex. Higher-level processing, such as processing of musical structure or expectations, requires components of the cerebral and frontal cortices (Levitin, D., 2020). Some critical regions of the brain that are known to be involved in music processing include the nucleus accumbens, the cerebellum, the hippocampus, the

amygdala, etc. The nucleus accumbens is a key structure that mediates emotion and motivation processing. It is also a crucial component of the mesolimbic system, a dopaminergic system (that releases dopamine) (ScienceDirect Topics., n.d.). Dopamine is commonly referred to as the "happy hormone"; it is a neurotransmitter that creates a sense of euphoria, which can be experienced when listening to music (Levitin, D., 2020). The cerebellum has many functions but is particularly important in the emotional aspect of music processing because of its connections to other regions of the brain that modulate emotion (Levitin, D., 2020). One such region of the brain is the amygdala, one of two almond-shaped clusters deep in the temporal lobe. The amygdala has been widely accepted as an integral part of emotional learning, which includes experiencing both emotions and motivation. Positron-emission tomography (PET) scans have shown that the amygdala is activated when listening to music, which suggests that it is at least partly responsible for the emotional responses experienced (Levitin, D., 2020). Lastly, the hippocampus is the memory center and is responsible for short-term, long-term, and spatial memory. Studies have found that the hippocampus is activated when listening to recurring musical phrases. The hippocampus also allows humans to recall familiar music, and its activation during music listening may result in improved memory, especially in Alzheimer's and dementia patients (ScienceDaily, 2014, Public Broadcasting Service, 2021). Recently, the hippocampus has also been found to lower cortisol levels, which reduces stress and anxiety and simultaneously allows for restful sleep.

Many hormones are involved in music processing and sleep, some of which have already been mentioned. Most notably, melatonin, which is a hormone that is released by the pineal gland and modulates the sleep-wake cycle. Therefore, melatonin is the principal hormone involved in sleep. A study mentioned above has found that music therapy has the ability to increase melatonin levels, which is an idea that merits further research. Serotonin is the precursor for melatonin and is directly linked to mood and happiness; listening to music releases both serotonin and dopamine. The last hormone that will be mentioned is cortisol, a stress hormone. Chronic stress has been linked to high cortisol levels (You and Your Hormones., n.d.). Since insomnia has been linked to stress, lowering cortisol levels is vital for promoting better sleep.

Rhythm Based Entrainment

There is evidence that music listening results in rhythm-based entrainment, or the synchronization of different rhythms (Harvard Health, 2021). Entrainment is applied in music therapy by attempting to decrease anxiety levels through the synchronization of a patient's biorhythms, such as heart rate, with the tempo of the music (Study.com, 2021). According to a Harvard study, entrainment results in the simultaneous activation of neurons from different areas of the brain. Brian Harris, from the Spaulding Rehabilitation Hospital, claims that "when you hear a steady rhythm, it activates your auditory system but also automatically engages your motor system," (Harvard Health, 2021). Therefore, music processing in the brainstem may affect respiratory rate, heart rate, and blood pressure because these functions are also controlled in the brainstem. If this is true, listening to steady music may actually be effective in modulating biorhythms, a phenomenon that would have beneficial effects in countless fields. This is extremely relevant to insomnia patients because high parasympathetic nervous system activity (which allows the body to relax and rest) is characterized by lowered biorhythms which, as previously mentioned, include heart rate, respiratory rate, and blood pressure. In other words, listening to slow music may activate the parasympathetic nervous system and allow for better sleep.

Conclusion

In reviewing the findings of studies conducted by other researchers, I have found music therapy and its effects on many patients to be exceptionally valuable, especially in the context of insomnia. As current methods of treatment for this increasingly common sleep disorder are insufficient, music therapy offers a unique alternative. Because of its extraordinary ability to activate nearly all regions of the brain, active music therapy prompts both a profound emotional response and the release of hormones such as dopamine and serotonin. This, in combination with a reduction in cortisol

levels, can ease anxiety and promote a more relaxed state that is optimal for initiating sleep. Rhythm-based entrainment is a mysterious phenomenon that is believed to prompt a similar response by synchronizing biorhythms. Even if these theories are not completely understood, current research strongly suggests that music therapy can enhance the quality of life for many insomnia patients by improving mood, sleep, and relieving stress in a non-pharmacological way; this makes a valid case for the wider use of music therapy in connection with treating insomnia.

Limitations

Specific applications and physiological mechanisms of music therapy must be further researched to be confirmed. Information in this article was collected through a literature review of currently available information, most of which was limited to articles in the public domain. Also, due to logistical constraints, no primary research was conducted. Additionally, music therapy has differential success rates among different individuals, and therefore should be applied in combination with other methods of treatments such as CBT or medications for optimal results. However, music therapy has seen tremendous positive effects in many people, and can absolutely be used to improve the quality of life for insomnia patients. Because of the many benefits of music therapy, as well as its attractiveness as a treatment with no known side effects, more resources could potentially be allocated to this field to make it a more viable treatment option.

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