Music and Epilepsy: A Literature Review

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Abstract

Epilepsy has been increasingly studied in relation to auditory stimuli. Research has demonstrated the health-promoting and seizure-inducing influence of music on the epileptic brain. The objective of this literature review is to investigate the potential therapeutic and adverse outcomes of music in people with epilepsy. Understanding how music and sound impact symptoms and rehabilitation in epilepsy patients may support the development of effective therapeutic and rehabilitative strategies for epilepsy. This review examines empirical studies, meta-analyses, and literature reviews to identify circumstances under which auditory stimuli may alleviate or trigger symptoms. Studies were reviewed for their designs, participant characteristics, auditory stimulus types, and outcome measures involving seizure frequency and epileptiform activity. Evidence indicates that certain musical stimuli, including specific compositions, and clinical interventions involving music training or exposure may reduce seizures and epileptiform discharges and contribute to psychosocial wellbeing. Conversely, music has also been reported to trigger seizures. The findings suggest a complex, context-dependent association between musical stimuli and restorative or detrimental outcomes on individuals with epilepsy. The underlying neural mechanisms for the therapeutic and adverse effects of music on epilepsy patients remain poorly understood. Further research is necessary to determine optimal conditions for safe, effective auditory-based treatment interventions and diagnostic procedures for epilepsy.

Keywords: epilepsy, music, seizures, epileptiform discharges, musicogenic epilepsy, music therapy, sound therapy

Introduction

Epilepsy is a neurological disorder characterized by abrupt and recurrent episodes of abnormal brain activity, often resulting in altered sensation, emotion, consciousness, or motor function(National Institute of Neurological Disorders and Stroke). Central to the diagnosis and understanding of epilepsy, seizures are sudden electrical disturbances in the brain that manifest with observable physical or behavioral symptoms, and epileptiform discharges. Epilepsy often includes interictal epileptiform discharges (IEDs) that occur between seizures, which are instances of brief abnormal electrical brain activity (National Institute of Neurological Disorders and Stroke; Valentine). Approximately 30% of individuals with epilepsy remain unresponsive to pharmacological interventions, underscoring the urgent need for safer and more affordable alternatives. Studies have revealed music's potential for reducing symptoms of epilepsy but have also suggested its capacity to trigger seizures. Given that approximately 1 in 156 of the global population suffers from epilepsy and only a fraction respond fully to existing treatments, investigating the complex relationship between music and epilepsy is both timely and necessary (Sesso and Sicca).

The relationship between music and epilepsy has long intrigued scholars, with early documentation dating back to 1841, when poet Jichin Kyo described adverse reactions to flute music that may have been music-induced seizures. The term "musicogenic epilepsy" was later coined in 1937 by Macdonald Critchley to describe seizures triggered by musical stimuli, often with criteria as specific as particular genres, instruments, or even composers (Maguire). Music's healing potential was recognized even by ancient Greek philosophers Plato and Pythagoras, whose writing detailed the benefits of music. Research into music therapy emerged in 1789, in a study by an unknown author titled "Music Physically Considered." Established in 1950 and 1971, respectively, the National Association for Music Therapy and the American Association for Music Therapy became the first major professional organizations for music therapy to treat a number of behavioral and physical conditions in America (Howland).

Music therapy aims to support psychological and physiological health through music exposure, performance, and composition (Howland). It has shown promise in improving wellbeing across various populations, yet its potential role in supporting epilepsy patients remains underexplored. Notwithstanding, the existing body of literature suggests positive impacts of music therapy among this population for symptom reduction and psychosocial rehabilitation (Abramaviciute and Aleksiene; Lin et al.; Maguire). Music therapy has demonstrated comparable health benefits alongside cognitive enhancement and emotional regulation in individuals with various neurological disorders, including but not limited to stroke, Parkinson's disease, Alzheimer's disease, and dementia (Lee et al.; Raglio et al.; Yang et al.). From an epilepsy-focused perspective, such therapeutic effects may offer insight into the interactions between music and the epileptic brain.

Musicogenic epilepsy exemplifies the dualistic nature of the impacts of music on the epileptic brain. Despite its low reported prevalence, this condition illustrates the need for careful consideration of music's neurological and emotional impact, particularly given the individual variability in susceptibility. The phenomenon underscores the importance of addressing both the beneficial and potentially detrimental effects of music within the broader scope of epilepsy research.

This literature review seeks to determine the potential therapeutic and adverse effects of music on individuals with epilepsy. The paper will examine music as a form of therapy for epilepsy, the broader therapeutic role of music in the context of treating neurological disorders, and cases of musicogenic epilepsy. Together, the subsequent syntheses of the literature on the aforementioned topics aim to provide a nuanced understanding of the dual potential of music to alleviate or exacerbate symptoms in epilepsy patients.

Results

Music Therapy for Epilepsy

A growing body of evidence suggests that music may have therapeutic effects on individuals with epilepsy, particularly in reducing seizure activity, epileptiform discharges, and psychosocial challenges. A study published in 2022 reviewed current neuroscience literature,

including experiments, pilot studies, and meta-analyses, and found that both audible and inaudible sound waves, especially focused ultrasound and Mozart compositions K.448 and K.545, were associated with reductions in epilepsy symptoms, though most findings were preliminary and limited in certainty (Maguire). Through a systematic review and meta-analysis, another study concluded that Mozart music could reduce interictal epileptiform discharges (IEDs) and seizure frequency, proposing musical neurostimulation as a potentially effective therapeutic strategy (Sesso and Sicca).

The aforementioned findings were further supported by an experimental study involving 64 Taiwanese children with epilepsy, 31 male and 33 female, ranging from two years and 11 months to 15 years and four months old (Lin et al.). Following International League Against Epilepsy (ILAE) guidelines for a consistent definition of epilepsy diagnoses, the authors performed simultaneous electroencephalogram and electrocardiogram examinations on the child subjects before, during, and after exposure to Mozart K.448 or K.545. They compared the frequency of epileptiform discharges in each session, proportional to its duration, and monitored the progression of the subjects' heart rates throughout sessions. Their evaluations demonstrated significant reductions in both heart rate and frequency of epileptiform discharges resulting from exposure to the selected Mozart pieces, with lowered heart rate often occurring simultaneously with reduced epileptiform discharges. The researchers concluded that music induced parasympathetic activation and suggested the potential involvement of parasympathetic activation in alleviating symptoms of epilepsy.

In addition to symptom reduction, music therapy may promote psychosocial well-being in people with epilepsy. In one pilot study, researchers formulated an online questionnaire containing eight questions for music therapists supporting clients with epilepsy regarding the content of their music therapy and the form of work, e.g., private or institutional work and individual or group practice (Abramaviciute and Aleksiene). The questionnaire was issued to several organizations related to music therapy, which included a total of 26 respondents from various countries across Europe. Based on the 11 replies they received, the researchers concluded that music therapy improved self-esteem, induced emotional release, enhanced communication skills, and provided group belonging in epilepsy patients undergoing psychosocial rehabilitation. However, it is important to note that such insights were based solely on therapist self-report.

Despite the promising findings reported in this body of literature, the current research is constrained by small sample sizes and heterogeneous methodologies, highlighting the need for further large-scale, controlled studies before music can be considered a standard component of epilepsy treatment.

Music Therapy for General Neurological Disorders

Beyond its potential benefits for epilepsy, music has shown therapeutic promise for a broader range of neurological disorders, improving both cognitive and emotional outcomes. To illustrate, an experimental study involving 25 stroke patients with minimal consciousness disturbance following stroke exposed subjects to musical stimuli at varying frequencies and

evaluated their brain responses through functional near-infrared spectroscopy, or fNIRS (Yang et al.). The researchers analyzed the connectivity between brain regions and the strength of neural interactions as indicated by coupling strength (CS) values. They found that exposure to musical stimuli at middle (0.5 Hz to 3.5 kHz) and high (greater than 3.5 kHz) frequencies significantly increased CS values, suggesting improved brain connectivity and potential awareness-promoting effects in patients with disorders of consciousness.

Providing further support for these findings, another research team reviewed 25 controlled trials examining the effects of music exposure and music therapy among patients with neurological disorders including dementia, stroke, Parkinson's disease, chronic quadriplegia, and acquired brain dysfunctions (Raglio et al.). The researchers categorized mere exposure to music as "music medicine" as opposed to music therapy, e.g., musical training, which requires a licensed therapist. They reported consistent improvements in mood, particularly reductions in depression and anxiety, and proposed that these effects result from the activation of limbic and paralimbic structures in the brain, including the amygdala and hippocampus; enhanced interpersonal connections, particularly through empathetic relationships fostered in music therapy; and improved motor functioning from making music, which enhances patients' sense of pleasure and fulfillment. Nevertheless, the studies examined were limited by a lack of methodological rigor due to the absence of double-blinding assessment.

Furthermore, another study reviewed the current literature (i.e., clinical trials, systematic reviews, observational studies, case studies, and meta-analyses) on a range of non-pharmacological therapies, such as music therapy, and determined that music contributed to improved mood, cognitive performance, consciousness level, and neuroplasticity in patients with Parkinson's, Alzheimer's, stroke, multiple sclerosis, epilepsy, dementia, and traumatic brain injury-induced coma (Lee et al.). Overall, their review provides support for the therapeutic effectiveness of music therapy for neurological disorder symptoms.

While these studies consistently highlight music's health-promoting effects on patients with neurological disorders, the current research base remains constrained by limited sample sizes and inconsistent methodological quality. Further controlled research is necessary to clarify underlying interactions between music and the brain and to determine how music can be reliably integrated into treatment protocols for neurological disorders.

Musicogenic Epilepsy

Research on musicogenic epilepsy, a rare form of epilepsy triggered by exposure to music has revealed a complex interplay of neurological, emotional, and immunological factors. One research team conducted a literature review of neuroscience case reports to investigate the conditions under which musical stimuli induce epilepsy symptoms (Bratu et al.). By analyzing two cases, they found seizures were triggered in one individual by music carrying emotional significance and in the other by neutral musical patterns associated with popular songs. MRI scans revealed abnormalities in the amygdala, hippocampus, and basal temporal lobe, brain regions involved in emotion and memory processing, while EEG data identified the temporal lobe as the seizure generator. The authors concluded that the emotional meaning of music may

influence its potential to induce seizures, but that musical triggers are variable and difficult to predict or regulate.

Another narrative literature review explored the prevalence, demographic patterns, and risk factors associated with musicogenic epilepsy (Francisco and Carvalho). Their analysis revealed an estimated prevalence of one in a million, though this figure may be an underrepresentation due to the absence of auditory stimuli in routine EEG assessments for epilepsy, potentially leaving cases of musicogenic epilepsy undetected. The average age of onset was 28, with a range from 2 to 67 years. Many seizures were triggered by music with high emotional resonance. Their findings also highlighted significant clinical associations: patients with musicogenic epilepsy frequently had co-occurring affective disorders and, in some cases, autoimmune encephalitis involving anti-GAD antibodies, which target the enzyme glutamic acid decarboxylase (GAD) responsible for synthesis of the inhibitory neurotransmitter GABA. Given the high prevalence of co-occurring affective disorders in musicogenic epilepsy, the authors suggested a possible link between the use of selective serotonin reuptake inhibitors (SSRIs), a common treatment for affective disorders, and seizure susceptibility.

A broader literature review in 2012 on the neurological relationship between music and epilepsy, with a subsection regarding musicogenic epilepsy, investigated the prominent role of emotion in musicogenic epilepsy (Maguire). The review identified a potential association between dopaminergic system modulation and music-induced seizures. Like the narrative literature review on musicogenic epilepsy prevalence, demographic patterns, and risk factors, this review concluded that musicogenic epilepsy may be more common than reported not only because routine EEG rarely assesses auditory seizure triggers, but also because delays commonly occur between music exposure and seizure onset. While the review also addressed music's therapeutic potential in other contexts, including improved spatial reasoning and seizure reduction following Mozart music exposure, evidence for a consistent anticonvulsant effect remained limited. Ultimately, Maguire's review emphasized the need for greater scientific clarity around both the harmful and healing properties of music in epilepsy.

To synthesize the outcomes described in this body of literature, emotional salience of the seizure-inducing stimulus was recognized across all the aforementioned investigations into musicogenic epilepsy. However, the highly individualized nature of musicogenic epilepsy necessitates further large-scale, controlled research for a comprehensive understanding of its triggers, underlying mechanisms, and management techniques.

Discussion

The current paper reviewed the existing body of research (i.e., meta-analyses, literature reviews, experimental trials, pilot studies, and case studies) on the therapeutic effects of music in individuals with epilepsy and other neurological disorders and on musicogenic epilepsy, an adverse effect of music on the epileptic brain. To synthesize, the literature reveals a complex relationship between music and epilepsy, characterized by both therapeutic promise and potential risk. For example, music has been shown to improve psychological and physiological outcomes in individuals with epilepsy (e.g., reduction of seizures and epileptiform discharges

and improved self-esteem and group solidarity in psychosocial rehabilitation), as well as in those with broader neurological disorders (e.g., heightened consciousness in patients with disorders of consciousness, increased connectivity between brain regions, and reduction in depression and anxiety), supporting the application of general neurorehabilitative findings to epilepsy-specific contexts. However, music may also act as a seizure trigger in rare cases, as seen in individuals with musicogenic epilepsy. More specifically, the research highlights the subjective significance of music to the listener as a consistently reported characteristic of seizure-inducing musical stimuli. This duality highlights an overarching inconsistency in the literature: while many studies emphasize the positive influence of music, others caution against its variable effects.

Ultimately, the evidence remains mixed and often constrained by small sample sizes, lack of replication, and limited control conditions. Existing studies rely primarily on case reports, EEG observations, and correlational data, which, though informative, fail to elucidate the specific brain mechanisms mediating music-epilepsy interactions.

To advance the field, future research should employ large-scale, controlled experiments that integrate neuroimaging methods such as fMRI with EEG to map the spatiotemporal brain dynamics involved in the perception and influence of music among individuals with epilepsy. Longitudinal designs and randomized controlled trials are also necessary to determine causality and establish whether music-based interventions are consistently safe and effective across epilepsy subtypes. The suggested involvement of subjective emotional or personal significance of musical stimuli in triggering seizures raises the potential research question of whether non-auditory emotion-eliciting stimuli, such as pictures, can also induce seizures.

These gaps have important implications for clinical and therapeutic practice. Medical professionals and music therapists should be cautious in implementing music-based interventions until more robust evidence emerges. However, with appropriate guidance, certain types of music may offer a promising, noninvasive adjunct to conventional treatment. Individuals with epilepsy should be encouraged to track their responses to different types of music, ideally in consultation with their healthcare providers, to identify patterns that may inform safe, personalized listening habits and treatment protocols.

The relationship between music and epilepsy holds invaluable potential for enhancing treatment protocols and quality of life for individuals with the neurological disorder.

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